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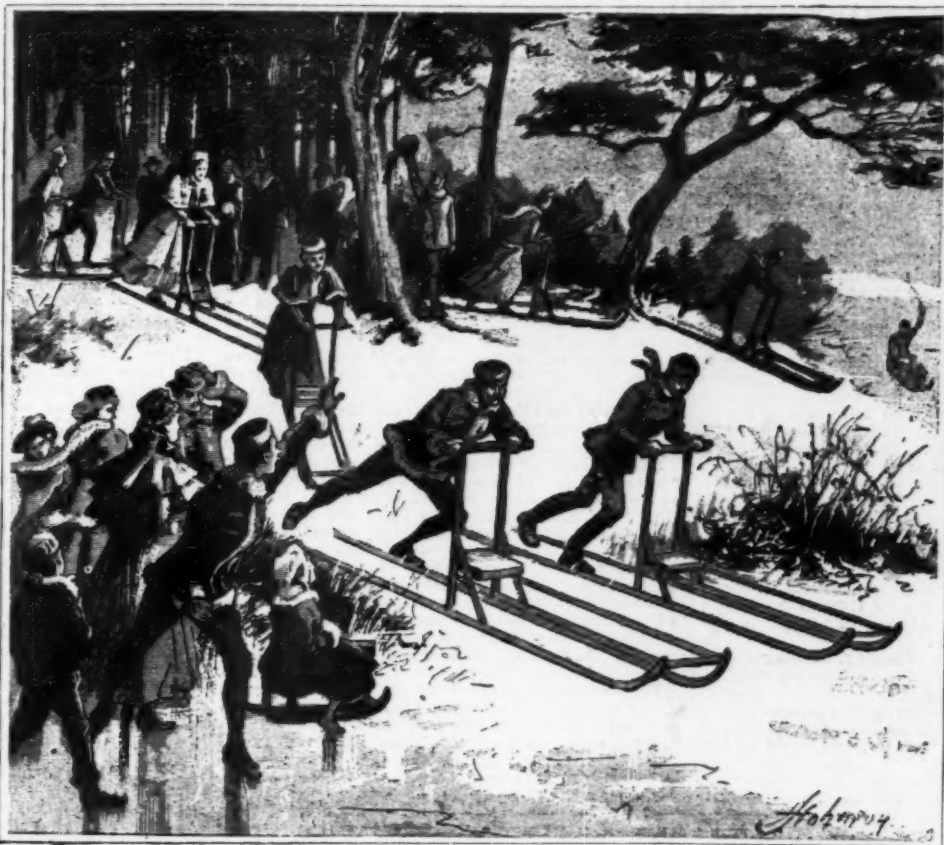
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### THE "RENNWOLF."

THE Berlin correspondent of the London Daily Graphic writes: Since last year sporting circles in this city have imported the Swedish "Rennwolf," and this delightful method of wintry locomotion has been widely indulged in of late. Twelve months ago it was intended by the sporting clubs to practice with the "Rennwolf," but the weather did not prove suitable. The temperature varied from day to day, and scarcely any snow fell; consequently the machines had to be laid up in lavender until a more rigorous visitation of frost should be vouchsafed to the "Rennwolf" runners. Happily the present winter has enabled them to realize their wishes. The snow has been plentiful and the ice good. Indeed, the conditions have been so favorable that regular "Rennwolf" races have been organized. The nature of the machine, which is a sort of push sleigh worked by the foot, will be gathered from the accompanying sketch. The runner has one foot firmly fixed on one of the sleigh irons, while he propels the machine by the occasional back push of his other foot against the ice or snow. The iron runners of the "Rennwolf" being from three to three and a half yards long, they are enabled to skate over inequalities in the track and



WINTER SPORTS IN GERMANY—A RUNNING RACE WITH THE "RENNWOLF."

patches of thin ice which with smaller machines would not support the travelers. During the fine winter afternoons of the past fortnight the Havel lakes near Potsdam have been crowded with ladies and gentlemen enjoying themselves on their "Rennwolves." In some cases children are placed on a seat on the machine, and they enjoy the sport enormously. Races between ladies and gentlemen have been in progress every day both on the river and the lakes. Frozen roads, well swept, are, however, equally adapted for "Rennwolf" running, and on the fine chaussees between Potsdam and Berlin the machines fly along like the wind. A speed of nine miles an hour is attained with the greatest ease. The runners wear a specially made boot on the propelling foot, studded with nails like a cricketing shoe, in order to give them a better hold of the ice or frozen ground.

Another form of winter amusement is skate sailing, of which we give a sketch from the Graphic.

The members of a skating club at Berlin meet on the Muggelsee, a large lake on the upper part of the river Spree, and among other races they have a skate sailing race, in which the competitors must not assist their progress by skating, but must allow the sail to do all the work.



SKATE SAILING AT BERLIN.

## THE INQUISITION IN MEXICO.

THE writings of Richard Hakluyt, an Englishman who lived in the time of Queen Elizabeth and Shakespeare, 1550-1620, are well known, especially his collections of voyages and discoveries. He was also a lecturer upon geography. His researches brought him into personal relations with all the most distinguished leaders of discovery expeditions, sea captains and intelligent seafaring men of his time, from whose dictation he prepared and published many interesting narratives. It is from this source that we derive the following abstracts of the experiences of an Englishman named Miles Phillips, who was a member of a trading and discovery expedition to Africa and America that was fitted out in England in 1567, and placed under the command of General Master John Hawkins. The expedition consisted of six vessels, namely, the *Jesus*, Robert Barret, master, in which Phillips embarked, the *Minion*, of which John Hampton was captain and John Garret master, the *William* and *John*, of which Thomas Bolton was captain and James Rance master, the *Judith*, captain and master Francis Drake (afterward famous as Sir Francis Drake, the great navigator and discoverer), and the *Angel* and the *Swallow*, masters' names not given.

On Monday, October 2, 1567, the little fleet set sail from Plymouth, and November 18 reached Cape Verde, on the coast of Africa, where they landed a force of 200 men and set about capturing negroes, with intent to sell them as slaves in the West Indies. After seizing some 500 of the blacks, they set sail for the west February 3, 1568, and in March reached the island of Dominica. Thence they coasted from place to place, trading and selling their slaves, visiting among other places Rio de la Hacha, and Cartagena, thence to Cuba, thence sailing toward Florida. Here a great storm occurred, during which they were driven far out of their course, and finally in a greatly damaged condition they put into Vera Cruz, on the coast of Mexico. Soon after anchoring, a large Spanish fleet entered the harbor, and after treacherous promises of safety by the Spaniards, it was not long before the Englishmen were attacked by an overwhelming force. Many of them were killed or captured, and all the English vessels were taken or destroyed except the *Minion* and the *Judith*. These two vessels managed to escape, crowded with men from the other ships. The same night the *Judith*, Captain Drake, parted from the *Minion*, and was seen no more. The *Minion* was so loaded down with people that the General Master Hawkins decided it to be necessary to set one half of them ashore, and this was done October 8, 1568. This unfortunate company, 114 in number, of whom Miles Phillips was one, were compelled to land on the inhospitable coast of Mexico, without food or proper clothing, and take their chances of butchery by savages or torture by the Spaniards, should the latter find them. The narrative of Phillips continues as follows:

The next morning—it being Tuesday, October 9th—we thought it best to travel along by the sea coast, to seek out some place of habitation—whether they were Christians or savages we were indifferent—so that we might have wherewithal to sustain our hungry bodies, and so departing from a hill where we had rested all night, not having any dry thread about us, for those that were not wet being thrown into the sea were thoroughly wet with rain, for all the night it rained cruelly. As we went from the hill and were come into the plain, we were greatly troubled to pass for the grass and woods, that grew there higher than any man. On the left hand we had the sea, and upon the right hand great woods, so that of necessity we must needs pass on our way westward through those marshes, and going thus, suddenly we were assaulted by the Indians, a warlike kind of people, which are in a manner as cannibals, although they do not feed upon man's flesh as cannibals do.

These people are called Chichimeci, and they used to wear their hair long, even down to their knees; they do also color their faces green, yellow, red, and blue, which maketh them to seem very ugly and terrible to behold. These people do keep wars against the Spaniards, of whom they have been oftentimes very cruelly handled: for with the Spaniards there is no mercy. They perceiving us at our first coming on land, supposed us to have been their enemies the bordering Spaniards; and having by their forerunners described what number we were, and how feeble and weak, without armor or weapon, they suddenly, according to their accustomed manner when they encounter with any people in warlike sort, raised a terrible and huge cry, and so came running fiercely upon us, shooting off their arrows as thick as hail, unto whose mercy we were constrained to yield, not having among us any kind of armor, nor yet weapon, saving one caliver and two old rusty swords, whereby to make any resistance or to save ourselves; which, when they perceived that we sought not any other than favor and mercy at their hands, and that we were not their enemies the Spaniards, they had compassion on us, and came and caused us all to sit down. And when they had a while surveyed and taken a perfect view of us, they came to all such as had any colored clothes among us, and those they did strip stark naked, and took their clothes away with them; but they that were appareled in black they did not meddle withal, and so went their ways and left us, without doing us any further hurt, only in the first brunt they killed eight of our men. And at our departure they, perceiving in what weak case we were, pointed us with their hands which way we should go to come to a town of the Spaniards, which, as we afterward perceived, was not past ten leagues from thence, using these words: "Tampeco, tampeco, Christiano, tampeco Christiano," which is as much (we think) as to say in English, "Go that way and you shall find the Christians." The weapons that they use are no other but bows and arrows, and their aim is so good that they very seldom miss to hit anything that they shoot at. Shortly after they had left us stripped, as aforesaid, we thought it best to divide ourselves into two companies, and so, being separated, half of us went under the leading one of Anthony Goddard, who is yet alive, and dwelleth at this instant in the town of Plymouth, whom before we chose to be captain over us all. And those that went under his leading, of which number I, Miles Phillips, was one, traveled westward—that way which the Indians with their hands had before pointed us to go. The other half went under the leading of one

John Hooper, whom they did choose for their captain, and with the company that went with him David Ingram was one, and they took their way and traveled northward. And shortly after, within the space of two days, they were again encountered by the savage people, and their Captain Hooper and two more of his company were slain. Then again they divided themselves; and some held on their way still northward, and other some, knowing that we were gone westward, sought to meet with us again, as, in truth, there was about the number of five-and-twenty or six-and-twenty of them that met with us in the space of four days again. And then we began to reckon among ourselves how many we were that were set on shore, and we found the number to be an hundred and fourteen, whereof two were drowned in the sea and eight were slain at the first encounter, so that there remained an hundred and four, of which five-and-twenty went westward with us, and two-and-fifty to the north with Hooper and Ingram; and, as Ingram since has often told me, there were not past three of their company slain, and there were but five-and-twenty of them that came again to us, so that of the company that went northward there is yet lacking, and not certainly heard of, the number of three-and-twenty men. And verily I do think that there are of them yet alive and married in the said country, at Sibola, as hereafter I do purpose (God willing) to discourse of more particularly, with the reasons and causes that make me so to think of them that were lacking, which were with David Ingram, Twide, Browne, and sundry others, whose names we could not remember. And being thus met again together we traveled on still westward, sometimes through such thick woods that we were enforced with cudgels to break away the brambles and bushes from tearing our naked bodies; other sometimes we should travel through the plains in such high grass that we could scarce see one another. And as we passed in some places we should have of our men slain, and fall down suddenly, being stricken by the Indians, which stood behind trees and bushes, in secret places, and so killed our men as they went by; for we went scattering in seeking of fruits to relieve ourselves. We were also oftentimes greatly annoyed with a kind of fly, which, in the Indian tongue, is called *tequani*; and the Spaniards call them *musketas*. There are also in the said country a number of other kind of flies, but none so noxious as these *tequanes* be. You shall hardly see them, they be so small: for they are scarce so big as a gnat. They will suck one's blood marvelously, and if you kill them while they are sucking they are so venomous that the place will swell extremely, even as one that is stung with a wasp or bee. But if you let them suck their fill, and to go away of themselves, then they do you no other hurt, but leave behind them a red spot somewhat bigger than a flea biting. At the first we were terribly troubled with these kind of flies, not knowing their qualities; and resistance we could make none against them, being naked. As for cold, we feared not any: the country there is always so warm.

And as we traveled thus for the space of ten or twelve days, our captain did oftentimes cause certain to go up into the tops of high trees, to see if they could descry any town or place of inhabitants, but they could not perceive any, and using often the same order to climb up into high trees, at the length they descied a great river, that fell from the northwest into the main sea; and presently after we heard an arquebuse shot off, which did greatly encourage us, for thereby we knew that we were near to some Christians, and did therefore hope shortly to find some succor and comfort; and within the space of one hour after, as we traveled, we heard a cock crow, which was also no small joy unto us; and so we came to the north side of the river of Panuco, where the Spaniards have certain salines, at which place it was that the arquebuse were shot off which before we heard; to which place we went not directly, but missing thereof, we left it about a bow shot upon our left hand. Of this river we drank very greedily, for we had not met with any water in six days before; and as we were here by the river's side resting ourselves, and longing to come to the place where the cock did crow, and where the arquebuse was shot off, we perceived many Spaniards upon the other side of the river riding up and down on horseback, and they, perceiving us, did suppose that we had been of the Indians, their bordering enemies, the Chichimeci. The river was not more than half a bow shot across, and presently one of the Spaniards took an Indian boat, called a *canoa*, and so came over, being rowed by two Indians; and, having taken the view of us, did presently row over back again to the Spaniards, who without any delay made out about the number of twenty horsemen, and embarking themselves in the *canoes*, they led their horses by the reins, swimming over after them; and being come over to that side of the river where we were, they saddled their horses, and being mounted upon them, with their lances charged, they came very fiercely running at us. Our captain, Anthony Goddard, seeing them come in that order, did persuade us to submit and yield ourselves unto them, for being naked, as we at this time were and without weapon, we could not make any resistance—whose bidding we obeyed; and upon the yielding of ourselves, they perceived us to be Christians and did call for more *canoes*, and carried us over by four and four in a boat; and being come on the other side, they understanding by our captain how long we had been without meat, imparted between two and two of a loaf of bread made of that country wheat, which the Spaniards called *maize*, of the bigness of one of our halfpenny loaves, which bread is named in the Indian tongue *clashacally*. This bread was very sweet and pleasant to us, for we had not eaten any for a long time before; and what is it that hunger doth not make to have a savory and delicate taste? Having thus imparted the bread among us, those which were men they sent afore to the town, having also many Indians, inhabitants of that place, to guard them. They which were young, as boys, and some such also as were feeble, they took upon their horses behind them and so carried us to the town where they dwelt, which was distant very near a mile from the place where we came over.

This town is well situated, and well replenished with all kinds of fruits, as pomegranates, oranges, lemons, apricots, and peaches, and sundry others, and is inhabited by a great number of tame Indians or Mexicans, and had in it also at that time about the number of

two hundred Spaniards, men, women, and children, besides negroes. Of their salines, which lie upon the west side of the river, more than a mile distant from thence, they make a great profit, for it is an excellent good merchandise there. The Indians do buy much thereof, and carry it up into the country, and there sell it to their own country people, in doubling the price. Also much of the salt made in this place is transported from thence by sea to sundry other places, as to Cuba, St. John de Ullua, and the other parts of Tamiago, and Tamachos, which are two barred havens west and by south above threescore leagues from St. John de Ullua. When we were all come to the town, the governor there showed himself very severe unto us, and threatened to hang us all; and then he demanded what money we had, which in truth was very little, for the Indians which we first met withal had in a manner taken all from us, and of that which they left the Spaniards which brought us over took away a good part also; howbeit, from Anthony Goddard the governor here had a chain of gold, which was given unto him at Cartagena by the governor there, and from others he had some small store of money; so that we accounted that among us all he had the number of five hundred pezos, besides the chain of gold.

And having thus satisfied himself, when he had taken all that we had, he caused us to be put into a little house, much like a hog sty, where we were almost smothered; and before we were thus shut up into that little cote, they gave us some of the country wheat called *maize* sodden, which they feed their hogs withal. But many of our men which had been hurt by the Indians at our first coming on land, whose wounds were very sore and grievous, desired to have the help of their surgeons to cure their wounds. The governor, and most of them all, answered, that we should have none other surgeon but the hangman, which should sufficiently heal us of all our griefs; and they, thus reviling us, and calling us English dogs and Lutheran heretics, we remained the space of three days in this miserable state, not knowing what should become of us, waiting every hour to be bereaved of our lives.

Upon the fourth day after our coming thither, and there remaining in a perplexity, looking every hour when we should suffer death, there came a great number of Indians and Spaniards armed to fetch us out of the house, and among them we espied one that brought a great many new halters, at the sight whereof we were greatly amazed, and made no other account but that we should presently have suffered death; and so, crying and calling to God for mercy and for forgiveness of our sins, we prepared ourselves to die; yet in the end, as the sequel showed, their meaning was not so; for when we were come out of the house, with those halters they bound our arms behind us, and so coupling us two and two together, they commanded us to march on through the town, and so along the country from place to place toward the city of Mexico, which is distant from Panuco west and by south the space of threescore leagues, having only but two Spaniards to conduct us, they being accompanied with a great number of Indians, warding on either side with bows and arrows, lest we should escape from them. And traveling in this order, upon the second day, at night, we came unto a town which the Indians call *Nohele*, and the Spaniards call it *Santa Maria*, in which town there is a house of White Friars, which did very courteously use us, and gave us hot meat, as mutton and broth, and garments also to cover ourselves withal, made of white baize. We fed very greedily of the meat and of the Indian fruit, called *nochole*, which fruit is long and small, much like in fashion to a little cucumber. Our greedy feeding caused us to fall sick of hot burning agues; and here at this place one Thomas Baker, one of our men, died of a hurt, for he had been before shot with an arrow into the throat at the first encounter.

The next morning, about ten of the clock, we departed from thence, bound two and two together, and guarded as before, and so traveled on our way toward Mexico, till we came to a town within forty leagues of Mexico, named *Mesticlan*, where is a house of Black Friars, and in this town there are about the number of three hundred Spaniards, both men, women, and children. The friars sent us meat from the house ready dressed, and the friars and men and women used us very courteously, and gave us some shirts and other such things as we lacked. Here our men were very sick of their agues, and with eating of another fruit, called in the Indian tongue *guiaecos*, which fruit did bind us sore. The next morning we departed from thence with our two Spaniards and Indian guard as aforesaid. Of these two Spaniards the one was an aged man, who all the way did very courteously entreat us, and would carefully go before to provide for us both meat and things necessary to the uttermost of his power. The other was a young man, who all the way traveled with us, and never departed from us, who was a very cruel catiff, and he carried a javelin in his hand, and sometimes when as our men with very feebleness and faintness were not able to go so fast as he required them, he would take his javelin in both his hands and strike them with the same between the neck and the shoulders so violently that he would strike them down, then would he cry and say: "Marches, marches, Engleses perros, Lutheranos, enemigos de Dios;" which is as much to say in English, "March, march on, you English dogs, Lutherans, enemies to God." And the next day we came to a town called *Pachuca*, and there are two places of that name, as this town of *Pachuca*, and the mines of *Pachuca*, which are mines of silver, and are about six leagues distant from this town of *Pachuca* toward the northwest.

Here at this town the good old man our governor suffered us to stay two days and two nights, having compassion of our sick and weak men, full sore against the mind of the young man his companion. From thence we took our journey, and traveled four or five days by little villages and *stantias*, which are farms or dairy houses of the Spaniards, and ever as we had need the good old man would still provide us sufficient of meats, fruits, and water to sustain us. At the end of which five days we came to a town within five leagues of Mexico, which is called *Quoghlican*, where we also staid one whole day and two nights, where was a fair house of Grey Friars, howbeit, we saw none of them. Here we were told by the Spaniards in the town that we had not more than fifteen English miles

from thence to Mexico, whereof we were all very joyful and glad, hoping that when we came thither we should either be relieved and set free out of bonds, or else be quickly dispatched out of our lives; for seeing ourselves thus carried bound from place to place, although some used us courteously, yet could we never joy nor be merry till we might perceive ourselves set free from that bondage, either by death or otherwise.

The next morning we departed from thence on our journey toward Mexico, and so traveled till we came within two leagues of it, where there was built by the Spaniards a very fair church, called Our Lady Church, in which there is an image of Our Lady of silver and gilt, being as high and as large as a tall woman, in which church, and before this image, there are as many lamps of silver as there be days in the year, which upon high days are all lighted. Whosoever any Spaniards pass by this church, although they be on horseback, they will alight and come into the church, and kneel before this image, and pray to Our Lady to defend them from all evil; so that whether he be horseman or footman he will not pass by, but first go into the church and pray as aforesaid, which if they do not, they think and believe that they shall never prosper, which image they call in the Spanish tongue *Nuestra Señora de Guadalupe*. At this place there are certain cold baths, which arise, springing up as though the water did seethe, the water whereof is somewhat brackish in taste, but very good for any that have any sore or wound to wash themselves therewith, for as they say, it healeth many; and every year once upon Our Lady Day, the people used to repair thither to offer and to pray in that church before the image, and they say that Our Lady of Guadalupe doth work a number of miracles. About this church there is not any town of Spaniards that is inhabited, but certain Indians do dwell there in houses of their own country building.

Here we were met by a great number of Spaniards on horseback, which came from Mexico to see us, both gentlemen and men of occupations, and they came as people to see a wonder; we were still called upon to march on, and so about four of the clock in the afternoon of the said day, we entered into the city of Mexico by the way or street called *La Calia Sancta Catherina*; and we stayed not in any place till we came to the house or palace of the Viceroy, Don Martin Henriquez, which standeth in the midst of the city, hard by the market place called *La Plaza dell Marques*. We had not stayed any long time at this place, but there was brought us by the Spaniards from the market place great store of meat, sufficient to have satisfied five times so many as we were; some also gave us hats, and some gave us money; in which place we stayed for the space of two hours, and from thence we were conveyed by water into large canoes to a hospital where certain of our men were lodged, which were taken before the fight at St. John de Ullua. We should have gone to Our Lady's Hospital, but that there were also so many of our men taken before at that fight that there was no room for us. After our coming thither, many of the company that came with me from Panuco died within the space of fourteen days; soon after which time we were taken forth from that place and put altogether into Our Lady's Hospital, in which place we were courteously used, and visited oftentimes by virtuous gentlemen and gentlewomen of the city, who brought us divers things to comfort us withal, as succats and marmalades and such other things, and would also many times give us many things, and that very liberally. In which hospital we remained for the space of six months, until we were all whole and sound of body, and then we were appointed by the Viceroy to be carried unto the town of Tescuco, which is distant from Mexico southwest eight leagues; in which town there are certain houses of correction and punishment for ill people called *orbraches*, like to Bridewell here in London; in which place divers Indians are sold for slaves, some for ten years and some for twelve. It was no small grief unto us when we understood that we should be carried thither, and to be used as slaves; we had rather be put to death, howbeit there was no remedy, but we were carried to the prison of Tescuco, where we were not put to any labor, but were very straightly kept and almost famished, yet by the good providence of our merciful God, we happened there to meet with one Robert Sweeting, who was the son of an Englishman born of a Spanish woman; this man could speak very good English, and by his means we were holpen very much with victuals from the Indians, as mutton, hens, and bread. And if we had not been so relieved we had surely perished; and yet all the provision that we had gotten that way was but slender. And continuing thus straightly kept in prison there for the space of two months, at length we agreed amongst ourselves to break forth of prison, come of it what would, for we were minded rather to suffer death than longer to live in that miserable state.

And so having escaped out of prison, we knew not what way to fly for the safety of ourselves; the night was dark, and it rained terribly, and not having any guide, we went we knew not whither, and in the morning at the appearing of the day, we perceived ourselves to be come hard to the city of Mexico, which was four-and-twenty English miles from Tescuco. The day being come, we were espied by the Spaniards, and pursued, and taken, and brought before the Viceroy and head justices, who threatened to hang us for breaking of the king's prison. Yet in the end they sent us into a garden belonging to the Viceroy, and coming thither, we found there our English gentlemen which were delivered as hostages when as our General was betrayed at St. John de Ullua, as is aforesaid, and with them we also found Robert Barret, the master of the Jesus, in which place we remained, laboring and doing such things as we were commanded for the space of four months, having but two sheep a day allowed to suffice us all, being very near a hundred men; and for bread we had every man two loaves a day of the quantity of one halfpenny loaf. At the end of which four months, they having removed our gentlemen hostages and the master of the Jesus to a prison in the Viceroy his own house, did cause it to be proclaimed, that what gentleman Spaniard soever was willing, or would have any Englishman to serve him, and be bound to keep him forthcoming to appear before the justices within one month after notice given, that they should repair to the said garden, and there take their choice; which proclamation was no sooner made but

the gentlemen came and repaired to the garden again, so that happy was he that could soonest get one of us. (To be continued.)

#### OIL TANK FIRED BY LIGHTNING.

PETROLEUM, or rock oil, has been known to mankind from time immemorial, and it may be found in nearly all parts of the world, but the first mention made of it is perhaps that by Herodotus in connection with the building of Babylon. In America there are found traces of naphtha wells in Pennsylvania, Ohio, and Canada, which in all probability were dug by the ancient Mound Builders.

The petroleum industry in this country dates from the year 1854, when the firm of Eleve & Bissell, of Titusville, Pa., conceived the idea of collecting and utilizing for illuminating and lubricating purposes the naphtha which up till then had been oozing sparingly from the ground in their neighborhood and which people had been in the habit of collecting for medicinal purposes, calling the same Seneca oil. The enterprise did not flourish until in 1859 G. L. Drake, the superintendent of the company, began borings, which he kept

Occasionally the contents of one of these gigantic structures will, by some unforeseen accident, be set on fire. The spectacle then presenting itself to the beholder is terribly magnificent, and spreads terror in the entire neighborhood. The flames, fed by a seemingly inexhaustible supply of the volatile combustible fluid, leap toward the sky to a height of hundreds of feet, only to be lost in a lurid background of clouds to which they themselves have given birth. When the darkness of night draws on the wondrous sight grows even more beautiful; for miles and miles around the country is illumined as by a giant torch, presenting a spectacle compared with which all of man's pyrotechnic displays dwindle into pygmean insignificance.

The accompanying illustration gives but a faint idea of the reality of an oil tank on fire. It is a half-tone reproduction of an instantaneous photograph of one of the largest tanks in the Ohio oil region ignited by a flash of lightning.—Western Druggist.

#### INTERESTING DISCOVERIES IN AFRICA.

A HANDSOME and gallant young officer in the German army has just made a name for himself in African



OIL TANK IGNITED BY LIGHTNING.

up for several months, when on the 26th day of August, at a depth of 71 feet, the drill "dropped" and the covered fluid at once rose to within a few inches of the shaft. The yield at once was 400 gallons a day, which amount soon was increased to 1,000 gallons. One year later, in 1860, there were in active operation in that region 2,000 oil wells. Since that time production and consumption have increased at an astonishing rate, as shown by the figures following, which give the average daily yield for the years indicated: 1859, 224 barrels; 1860, 1,380; 1865, 9,583; 1870, 14,542; 1875, 24,517; 1880, 71,107; 1882, 82,303; 1885, 56,921; 1886, 71,000; 1887, 50,000; 1890, 80,000; 1893, 91,300; 1894, 84,000.

The first man to construct a pipe line, in order to reduce transportation expenses, was Samuel Van Syckle, of Morris County, N. J. This was five miles in length. In 1875 the first pipe line to the seaboard was completed, while at present probably 6,000 miles of pipe are laid. These pipes usually consist of two 6 inch wrought iron pipes tested to a pressure of 2,000 pounds to the square inch. The tanks in which the petroleum is stored are huge sheet iron structures holding from 10,000 to 75,000 barrels. The more common size is 30 feet high and 86 feet diameter, with a capacity of 30,000 barrels. Such a structure has a weight of 80 tons.

exploration. He is Lieutenant Count Von Gotzen, a young fellow who has a very large fortune and a boundless ambition to accomplish something in the world. In December last he completed the thirteenth crossing of tropical Africa, from sea to sea, and it was a most eventful journey, for he chose his route nearly half the way through districts which no white man had visited, and he made some important and very interesting discoveries. He has stood on the crater wall of the only active volcano in Africa; he has found large lakes that were never heard of before, and he has traced at least one important river from source to mouth.

It is a fine thing for an explorer to have a large fortune of his own, for then he has only to put his hand in his pocket, supply his needs, and he asks no favor of anybody. Most of the great explorers begin in a humble way, and years elapse before they acquire a reputation that brings them before the world and makes it an easy matter to raise the money for large projects. Lieutenant Von Gotzen's expedition has cost him not a cent less than \$100,000. When he left the Indian Ocean in October, 1893, and started inland, he was at the head of one of the largest and best equipped expeditions that ever entered Africa. He spared no money

to make his enterprise a success. His party was the largest ever formed for exploration in tropical Africa.

The fact that he had very few men on the sick list speaks volumes for the excellence of his equipment, and shows that the experience gained by many explorers has, at last, deprived African exploration of most of its dangers.

He started from the port of Pangani, a little north of Zanzibar, with 518 persons in his caravan, of whom 400 were black porters and 33 were soldiers. Among his white comrades were a geologist and a physician, and he had made so little stir in all the work of organizing his big enterprise that the world hardly knew he had started. It was only after he began to send home news of fresh discoveries that wide attention was called to him.

He made a small experiment with Indian elephants as baggage carriers, two of which he imported from India. We do not know why his experiment failed, but, at any rate, he abandoned his elephants after a few days' march, and at last accounts the animals were doing good service carrying timbers for the railroad which the Germans are pushing inland from the Indian Ocean. He made his first important discovery after traveling about 300 miles toward Victoria Nyanza, when he suddenly came upon the large salt Lake Umburro, which is one of the most southern of that remarkable chain of dead seas extending hundreds of miles north and south a considerable distance east of Victoria Nyanza. Here is a very long, wide rift in the earth whose drainage cannot escape to the sea, but settles in these depressions, forming a series of big and small salt lakes. Explorers had never heard of Lake Umburro before, although they had passed both north and south of it.

Over a hundred miles directly west of Victoria Nyanza is the large country of Ruanda, lying partly in the Congo State and partly in German East Africa. No European had ever penetrated this region, and we knew nothing of Ruanda except a few vague facts supplied by Stanley, Stuhlmann and Baumann, who skirted its eastern edge. Von Gotzen crossed this populous region, whose inhabitants are a fine-looking race. Everybody has heard of the terrible cattle plague that, a few years ago, wiped out the greater part of the herds across tropical Africa from sea to sea. The pride of Ruanda used to be the innumerable herds of big-horned cattle that cropped its nutritious grasses, but during the reign of the plague they were almost wholly destroyed. The country was nearly ruined, but little by little the herds are growing again, and in a few years more they will reach their old proportions. The king has the title of Kigeri. He has a dozen residences in various places, at one of which he gave the explorer's party a hospitable reception. The Arab traders have tried in vain to penetrate this country. They have always been repulsed, and not a single Arab did Von Gotzen meet in this part of Africa.

In Ruanda the explorer saw the only active volcano that has been discovered in Africa, and there is reason to believe that no other will ever be found. We have known since 1891 that there was in this region a smoking mountain, for the natives further north told Emin Pasha and Dr. Stuhlmann that there was a great mountain from which black smoke came, and that ashes were sometimes sifted over the country, and when there was the most smoke they heard a noise like the bellowing of many cattle. It was not at all probable that these natives could have invented such a story, and it was quite certain that explorers were on the eve of finding, at last, a volcano in the heart of Africa. The prize was reserved for Von Gotzen. When Speke discovered Victoria Nyanza the natives told him of a mountain, far west of the lake, which they called Mount Mfumbiro. He placed it on his map, and when the mountain was first seen, three years ago, it was found to be the most northern of a chain of six volcanic mountains extending to the southeast. The most southern of these is the fire mountain, Kirunga.

Von Gotzen saw it from afar as he approached the mountain from the east. Its name is really a phrase of which Kirunga is the most important word, and the whole means "the place where sacrifices are burned." It rises above the plain to a height of about 11,130 feet. The white men saw its smoke rising gently above the top for three days before, pushing through the dense vegetation, they reached the base of the mountain. Then they eagerly pushed up the steep slope, and at last they stood upon the edge of the crater wall and looked down upon a spectacle that riveted every gaze.

The crater is about a mile in diameter and the wall that hem it in is nearly circular. The crest of the encircling wall is several hundred feet above the bottom of the crater. The angle of slope down to the bottom is about seventy degrees; so steep that it would be difficult of descent, and the spectacle spread before the visitors on the crater bed did not tempt them at all to make any effort to reach it. As near as they could make out through the steam and yellow smoke, the bottom of the crater was a lake of molten, reddish lava. It looked like marble of a yellow-brown color, and the only way that they could determine that it was liquid or nearly so was an occasional disturbance of the surface. Rising above the surface of this bright hued lake was a large orifice descending into the bowels of the mountain. It was over 400 feet in diameter, and out of this immense cavity was pouring a great column of yellow smoke that was almost stifling when the breeze, now and then, enveloped the explorers in its dense volume. They were then compelled to retreat down the side of the mountain to get beyond the reach of the overpowering fumes. The smoke rolled in dense waves around the bottom of the crater and in places poured over the edge. Now and then a puff of unusual energy would carry a column of smoke high into the air and clear the crater enough so that the spectators might get some idea of the appearance of the bottom. The incessant ebullition was accompanied by a loud noise like the roll of thunder, of sufficient volume to drown most other sounds, and the visitors had to talk at the top of their voices to make one another heard. Fortunately for them, no solid substances were ejected during their visit. If a violent eruption had been in progress, of course, they would not have attempted to reach the top.

At a short distance from the big chimney was

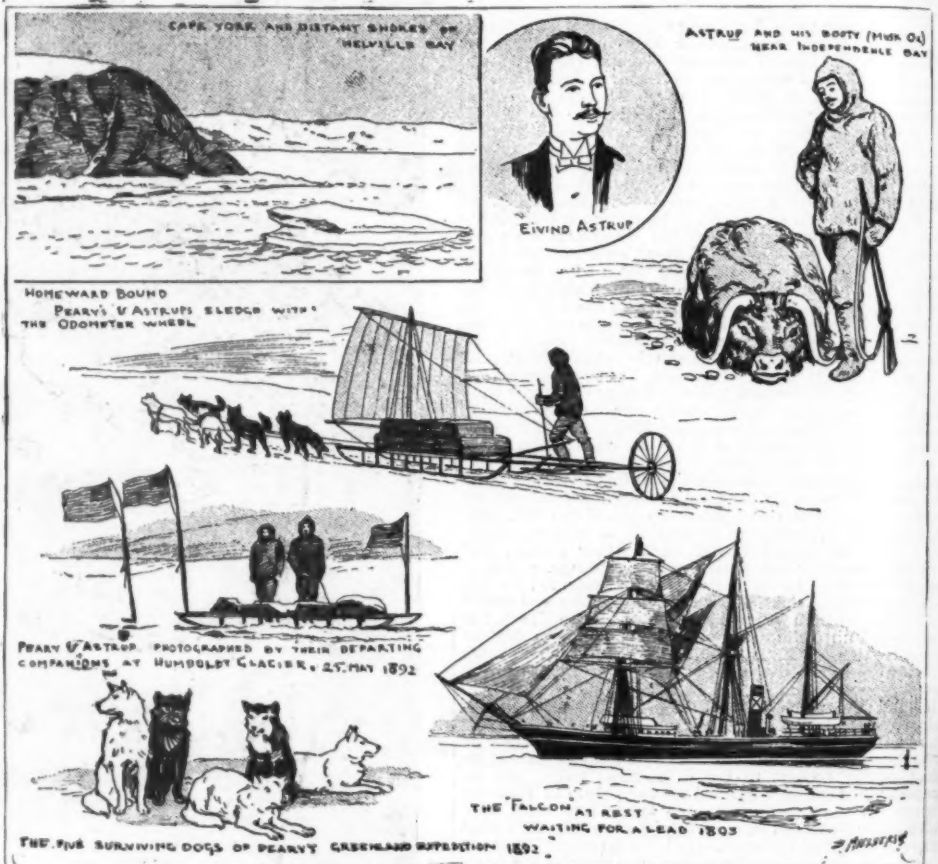
another, about half the size, which appeared to be in a quiescent state. Von Gotzen believed, from disturbances that were apparent near the western edge of the crater, that another center of eruption exists there, but the smoke obscured his view of this part of the crater, and in the time he could spend on top of the mountain he was unable to push through the timber and grass that clothes its sides to the point above where the disturbance appeared to be. At any rate, he had discovered a most respectable volcano in a region that was once a center of great plutonic activity. Perhaps it was long before man existed that the great convulsions occurred which made the long, deep rift in the earth's surface, now filled by the waters of Tanganyika, and which found vent in a line of volcanoes stretching far north on both sides of Victoria Nyanza. The feeble, expiring energy of this period is still found in a few hot springs and solfataras, but only Kirunga exists in an active state, the last of the African catalogue of big fire mountains.

Right at the southern foot of this mountain the explorer made another interesting discovery. It is the big Lake Kivu, of which Stanley heard vague reports from the natives, which he placed on his map under the name of Rivo. It is about half way between Lakes Tanganyika and Albert Edward, and according to Von Gotzen, it is nearly as large as the latter lake. He did not, however, see its southern shores. He journeyed for days along its northern coast, and far to the south he could see a large island in the central part of the lake, both east and west of which was a water horizon. The natives told him that the land in view was an island, and that beyond it the lake still extended to the south for about one-third of its entire length. We now are certain that this lake sends its waters through the Rusizi River to Tanganyika. The river enters the

lack of food if it had not been for the herds of cattle they had driven all the way from the Mami country east of the lake region. At last they emerged from the unknown, at the banks of the Congo, and on December 8 last, when the expedition had reached the mouth of the great river, the news was flashed to Europe and America of the brilliant success of the thirteenth crossing of Africa.—New York Sun.

#### THE PEARY EXPEDITION.

A CORRESPONDENT of the Daily Graphic, London, says that Elvind Astrup, Lieutenant Peary's chief officer, having lately returned to Christiania, has addressed a crowded meeting of the Norwegian Geographical Society on the subject of the Peary Greenland Expedition, his own (Astrup's) new discoveries in Melville Bay, and on Arctic exploration generally. The lecture was rendered doubly interesting by dissolving views—photographs taken on the spot by himself—which enabled the audience to realize the attractions—or horrors—of northern Greenland. Astrup is a young, energetic Norwegian—only twenty-three years of age—and during the last three years has seen more of Arctic life, and made greater discoveries under the Frigid Zone, than any previous explorer of such tender years. Referring to Arctic exploration generally, he expressed the fullest confidence in Nansen's return—which would be facilitated by the wonderful completeness and appropriateness of his outfit and equipment—but he would in all probability be without his ship. He spoke hopefully of Jackson's plans leading to very successful results, provided the Windward reached Franz Josef Land, but he thought she was probably drifting in the ice, like the Tegethoff in 1872. In respect to Peary's attempt to cross Greenland during



REMINISCENCES OF THE PEARY EXPEDITION—EIVIND ASTRUP AND SOME OF THE PICTURES WHICH ILLUSTRATED HIS LECTURE BEFORE THE NORWEGIAN GEOGRAPHICAL SOCIETY AT CHRISTIANIA.

big lake at its northern end, and the question whence it comes, which was debated by Burton, Livingstone, and Stanley, is at last settled. The altitude of Lake Kivu is high above that of the large sea to which it is tributary, and as its waters descend nearly half a mile nearer the sea level before they reach Tanganyika, there must be many a fall and rapid in the short course of the Rusizi.

West of the big volcano the expedition spent nearly three months among lofty mountains that form the water parting here between the Congo and Nile systems. It was an utterly unknown region, so high above the sea that for some time the party suffered greatly from cold, the mercury falling at night to within three degrees of the freezing point. Few people live in this region of immense forests and giant bamboos. Then the party began the descent of the Lova, a large eastern tributary of the Congo. They traced it from its sources to the Congo, and have thus delineated another large stream on the maps of Africa. On this part of the journey they were near the southern edge of the great forest which Stanley had traversed over 150 miles to the north. There is here no such dense growth of vegetation as he described. The foliage is not here so dense as to exclude the rays of the sun. In the more open places are big towns, and in one of them, where 5,000 people live, was an Arab merchant who was simply stupefied at the apparition of white men from the east. White men from the west had hunted his slave-catching brethren out of the Congo State, and he had taken refuge here in fancied security, only to be pounced upon by the dreaded enemy from another direction. Nothing could exceed his gratitude when he was assured that he would not be harmed. On the lower reaches of the river the expedition would have suffered greatly for

the present year he spoke reservedly, but considered that it would be a failure, as he had but few resources at hand, and could not depend on the Eskimo accompanying him, the latter believing the ice cap to be haunted by spirits. Astrup, however, considers Peary to be possessed of every quality necessary in a leader of an expedition—energy, courage, determination, and practical sense.

He related some comic incidents from his life with the natives. Sleeping one night with twenty Eskimos in a snow hut, he was obliged to make one boy a pillow, and five others, lying transversely, his coverlet. One unfortunate Eskimo, having injured his foot, had to have it amputated. The operation was performed with an old, blubber-covered knife, while the bleeding was stopped by ligatures of sinews. This individual recovered, and was subsequently seen by Astrup moving about with a "wooden leg" made of narwhal ivory. He referred to the natives' love of music, and their quick appreciation of song, as they soon picked up and intoned the striking melodies of the Norwegian national "Yes, indeed, we love our country," and the universal "Ta-ra-ra-boom-de-ay." He admired the Eskimo, not for their beauty, but for their genial, naive and hospitable qualities, and for their fearless daring in the chase—attacking, as they do, bears single-handed when armed solely with a knife. His admiration for the natives appears to be surpassed only by his love for the dogs, which will often do the hardest possible work for three days without viands.

THE statistics of life insurance people show that in the last twenty-five years the average of man's life has increased five per cent., or two whole years, from 41.9 to 43.9 years.

# THE OUNCE OR SNOW PANTHER.

THE animal commonly designated as the snow panther is the ounce of Buffon, the irbis of the Mongolians, the ilbis of the Turkomans and the Felis uncia of naturalists. The animal inhabits Asia, and the name of snow panther given it by European hunters indicates the special habits that characterize this species. Of all the large felines, this is the one that ascends mountains the highest and best withstands the low temperatures that prevail at the limit of perpetual snow.

In its form and system of coloration the ounce much resembles the common panther, but the soft tint and length of its fur indicate at a glance an animal organized for living in a colder climate. Its size reaches that of the largest panthers, but its color is a light gray, without any admixture of tawny, from which detach themselves black spots that are larger and more widely spaced than those of the panther, and more like those of the coat of the jaguar. The tail, which is as long as the body, is much thicker than that of the panther, and it, likewise, is provided with black spots which, in the posterior third, have a tendency to form rings. The hair is long and woolly, especially upon the flanks, and becomes still more beautiful in winter, when the spots insensibly blend with the ground color and give it a most elegant undulate aspect, which causes it to be esteemed as a choice fur.

With these external differences are connected others, which are not very perceptible except in the skull of the animal. The face is short and separated from the forehead by a well marked depression, and thus offers

tween the pine and birch forests and the eternal snows. It feeds upon burrhals (*Pseudovis burrhali*), muffs (Ovis nahura), sheep, goats and domestic dogs, but it never attacks man, and even hides at his approach. It is for this reason that it seems more rare than it really is. An Englishman, who had long devoted himself to hunting the ounce, said jokingly upon this subject that he had never seen but a dozen specimens, but that he had certainly been seen by more than a hundred.

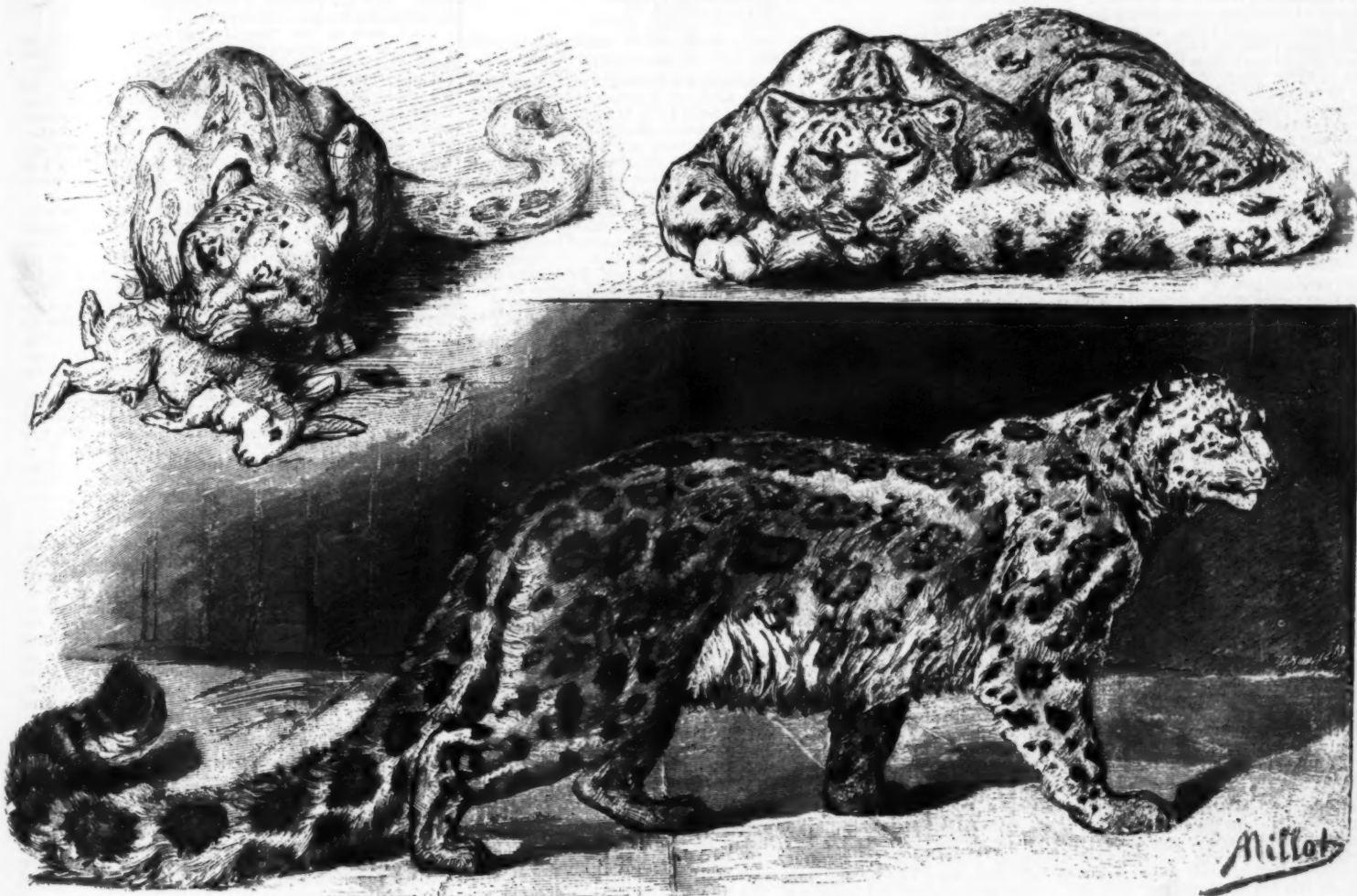
Although the pupil of its eye is round, like that of the lion, tiger, and other large felines, the ounce keeps concealed during the whole day and hunts during the night only. Like the other large cats, it sits upon the watch for its prey, and, with a single bound, alights upon the animal's back, or else it prowls about for hours, and noiselessly glides behind thickets so as to approach a flock of sheep unawares. As game is rare in the region that it inhabits, it is very persistent in its pursuit. When a flock poorly guarded by dogs allows itself to be surprised, and the ounce is holding a sheep that it has slaughtered, it would rather allow itself to be bombarded with stones than let go its hold.

The skin of the ounce is much sought after by hunters, since it is used for making pelisses, rugs, and lap robes. The emirs of Turkestan pay a high price for it to the Chinese, who carry on the trade in furs. The subdued tints of this warm and soft fur give it a badge of distinction, and the rareness of the animal that wears it still further enhances its value. It is difficult to fix the price of this fur, even approximately, and the more so in that it varies according to size, and to the age of the animal and the season in which the

the Jardin des Plantes, of Paris, has just received through Prince A. Gagarine is three years old and came from the mountains of Turkestan. The animal has probably not yet attained its full development. Its size, nevertheless, is that of an ordinary panther. Its head is small and recalls that of the guepard. Its contours are elegant and its motions quick and undulatory, and it has a more wideawake appearance than the majority of the large cats usually kept in menageries. Its coat is of a yellowish gray with the public usually likens to mastic color, set off with black spots that are much larger and less numerous than those of the panther and its Asiatic varieties (*Felis tiliensis*, *F. fontanieri*, etc.) In this respect, as we have said, the ounce is comparable with the American jaguar only. It is known, moreover, that these spots vary passably from one specimen to another. Thus, the spots of the lumbar region of the largest of the three mounted specimens that figure in the galleries of the museum are very distinct, while in the two other specimens they are confluent and form irregular stripes.

The fur is white on the face and on the belly. The tail is very beautiful and of the color of the back, with black spots forming irregular rings, and it is much thicker, longer and more tufted than that of the ordinary panther.

The fur is not as long as one might expect to see it in the middle of winter, but it must not be forgotten that the animal has already been in captivity for several months and that this has withdrawn it from the natural influences that might have caused its fur to grow and become thick, that is to



THE SNOW PANTHER OF THE JARDIN DES PLANTES OF PARIS.

a contrast with the rounded profile of the common panther. But even if these osteological differences did not exist, it would be easy to distinguish the two species merely by an examination of the fur. We shall see, however, that they have long been confounded for want of a knowledge of the true characters of the snow panther, which are very sharply defined, as shown by the description that we have just given.

The ounce inhabits the mountainous regions of the central plateau of Asia, from the north of Persia to the valley of the Amoor and the Sakhalian Islands. In the Himalayan chain it ascends to 9,000 and even 18,000 feet, a height at which scarcely any other animal exists, and it is found also upon the Tibetan side of this great chain. During his voyage with Humboldt, Ehrenberg found it in the Altai. Schrenck on the river Amoor and the Sakhalian Islands, and Fontanier in Western China. More recently the Russian traveler Przewalski has observed it in the majority of the mountains of Central Asia, in the country of the Tongouses, and especially in the chain of Tetung-sud and near the monastery of Tschetyrton. In the mountains that border the Tetung-gol it is rarer. It also inhabits the chain of Tian Chan, and particularly the mountains following the course of the Kung and the Jildus, then Altyn-thag and the Russian and Korean chain. More to the east, in China and Mongolia, it is found in the Nan-Chan mountains, and particularly to the south of the oasis of Ssi-Teheon. As may be seen, its area of dispersion is very vast. In all these localities, however, the species is considered as rare.

The snow panther generally keeps to steppes covered with thinly scattered thickets, and to the limit be-

latter is killed—the winter coat being much more beautiful than that of summer. It suffices to say that the skin reaches a higher figure than that of the common panther, although the latter brings a pretty respectable price.

But it is well to know that the common panther likewise inhabits the mountainous regions of Central Asia, that its coat there exhibits paler tints than those of the panther of warm countries, and that it is often difficult to distinguish it from the true ounce. It is very probable that fur dealers are only too ready to take advantage of such resemblance and to sell the skins of the two species under the same name. They are excusable to a certain degree, since naturalists themselves have not always been able to see the difference, and in many recent books the animal that is still figured under the name of the ounce is evidently only a panther of a pale color. It is only quite recently that the confusion existing between the two species has been almost completely cleared up. In a general way, it may be said that every Asiatic panther that presents very distinct traces of yellow, with closely arranged spots, belongs to the common species, that is to say, to *Felis pardus*. The coat of the ounce is gray, with irregular black ragged-edged spots, the shade verging slightly on lilac. Besides, the true ounce, after reaching an adult age, is very much larger than any other variety of the panther proper to Central Asia. In these cold and mountainous regions the ounce is in its true country, while the panther seems as if out of place, and this is what explains its small size.

The specimen of snow panther that the Museum of

say, from the severe cold that prevails upon the high mountains in which this animal delights.

For our engravings we are indebted to L'illustration.

## NOTES ON THE BIOLOGY OF THE LOBSTER.\*

**REPRODUCTION.**—After hatching a brood in May, the female usually moults and afterward extrudes a new batch of eggs. In this case egg-laying follows close upon copulation. Sometimes a female is impregnated immediately after the old eggs are hatched and before the moult occurs. A second copulation is then necessary for the fertilization of the eggs. Occasionally the seminal receptacle of a lobster is found loaded with sperm a year before the eggs are due.

**Laying of Eggs.**—Much confusion has surrounded this subject because of the lack of continuous observation throughout the year. The facts seem to be as follows: The majority of lobsters capable of spawning lay eggs in July and August. About 20 to 25 per cent.

\* This paper was read before the Society of Morphologists, Baltimore, December 28, 1894.

These observations are from part of a prolonged investigation of the habits and development of the lobster, undertaken for the U. S. Fish Commission. The detailed work, now ready to go to press, will be published in the Fish Commission's Bulletin. It will contain a full presentation and discussion of the habits and general life history of the adult lobster, and the habits of the larva and young during their period of immaturity. The history of the larva and the structure and development of the reproductive organs will be fully described and the development of the embryo will also be reviewed. The work is illustrated by 54 full page plates, many of which are executed in colors or reproduced from photographs, and by 40 figures in the text.—Science.

extrude their eggs at other times, it may be in the fall, winter or spring. During a period of seven consecutive months five traps were kept set in the harbor of Wood's Holl, Mass., December 1, 1893, to June 30, 1894, and visited daily. In all 166 egg lobsters were taken; 44, or 25.6 per cent. of the number, bore eggs which had been laid in the fall and winter.

I have tabulated 51 lobsters coming from different parts of the coast of Maine, having external eggs which had been laid out of the usual season of July and August. In one case at Matinicus Id., Maine, February 4, the eggs had been extruded but a few hours, and the yolk was unsegmented. Another from York Id., Maine, November 15, had eggs in a late state of segmentation of the yolk. Still another from Brimstone Id., Maine, January 27, had eggs in the nauplius stage. At Wood's Holl, 1889 to 1893, the recorded observations (over 300 in all) show that the greatest number of eggs are laid in the last two weeks of July, the whole period lasting from June 16 to August 31. Data from the Maine coast (129 observations) indicate that the greatest number spawn in the first two weeks of August.

The spawning period of lobsters in the extreme north is said to last from July 20 to August 20, in Newfoundland. July and August are the months commonly assigned for the spawning in Prince Edward Island.

**Number of Eggs Laid and Law of Production.**—In the course of the work of lobster hatching at the station of the United States Fish Commission at Wood's Holl, it becomes necessary to remove the eggs from a large number of lobsters. These are carefully measured and the number deduced by simple calculation. I have tabulated the number of eggs laid in 4,645 lobsters measuring from 8 to 19 inches. In examining the column of averages one is struck by the fact that a ten inch lobster bears twice as many eggs as one eight inches long; that a twelve inch lobster bears twice as many as one ten inches long. It is therefore suggested that in early years of sexual vigor there is a general law of fecundity which may be thus formulated: the number of eggs produced by female lobsters at each reproductive period varies in a geometrical series; while the lengths of lobsters producing these eggs vary in an arithmetical series. If such a law prevails, we would have the following:

Series of lengths in inches.

(1)	(2)	(3)	(4)	(5)	(6)
8	10	12	14	16	18

Series of eggs:

5,000 : 10,000 : 20,000 : 40,000 : 80,000 : 160,000

An examination of the table shows how closely the first four terms of this series are represented in nature, and that when the 14-16 inch limit is reached there is a decline in sexual activity. Yet the largest number of eggs recorded for lobsters of this size show that there is a tendency to maintain this high standard of production even at an advanced stage of sexual life.

A graphic representation of the fecundity of the lobster tells more forcibly than words or figures can do how closely it conforms to the law just enunciated. The curve which we obtain is the wing of a parabola; the curve of fecundity is parabolic up to the fourth term, where the ratio of production is distinctly lessened. The largest lobster, carrying the largest number of eggs, was obtained at No Man's Land, June 9, 1894. It was sixteen inches long and carried one pound of eggs, estimated to contain 97,440. It is safe to assume that the average number of eggs laid by a lobster eight inches long is not above 5,000. The large lobster just mentioned, on account of the incumbrance of its eggs, was unable to fold its "tail," which suggests the explanation of the rudimentary condition of the first pair of swimmerets. If these appendages were of the average size, the large number of eggs which would naturally adhere to them would make folding of the abdomen impossible, and it is by folding the "tail" that the egg-bearing lobster so successfully protects her eggs and eludes her enemies.

**Period of Incubation.**—Summer eggs which are laid in July and August are ordinarily hatched in June, after a period of from ten to eleven months. Nothing is known about the hatching of fall and winter eggs. The majority of the eggs which are hatched at Wood's Holl complete their development in June.

That young are hatched at other times is certain, and we should expect this to be the case from the variations which occur in the time of ovulation. Capt. Chester in 1885 hatched some eggs at Wood's Holl Station on the 8th of November and the following days, the temperature of the water varying from 54.3 to 56 deg. Fah. Some lobsters were hatched early in February in 1889 at the hatchery of the Fish Commission Station at Gloucester, Mass. The water was very cold, and it was estimated that as many as 10,000 lobsters were hatched.

**Period of Sexual Maturity.**—Lobsters become mature when measuring from 7½ to 12 inches in length. Very few under 9 inches long have ever laid eggs, while but few have reached the length of 10½ inches without having done so. The majority of female lobsters 10½ inches long are mature. Anatomical evidence shows that the period at which lobsters become mature is a variable one, extending over several years.

**Frequency of Spawning.**—The adult lobster is not an annual spawner, but produces eggs once in two years. This is proved by the anatomical study of the reproductive organs, and confirmed by the percentage of egg-bearing lobsters which are annually captured. In a total catch of 2,657 lobsters, December 1 to June 30, 1893 and 1894, the sexes were very nearly equally divided, and about one-fifth of the mature females caught bore external eggs. The catch off No Man's Land in 1894 amounted to 1,518 lobsters; 93.5 per cent. were females, and 63.7 per cent. carried eggs. When these results are averaged it is found that about one-half of the females carried eggs, as would be the case if they spawned every other year. Ehrenbaum is without doubt mistaken in supposing that the lobster does not breed oftener than once in four years (Der Helgolander Humer, ein Gegenstand deutscher Fischelei. Aus der Biologischen Anstalt auf Helgoland, 1894).

**Gastroliths.**—Gastroliths are known only in two Macroura, the lobster and crayfish, and were observed in the lobster for the first time, and recorded by Geoffroy the Younger, in 1709. Though a differentiated part of the cuticle, they are not cast off in the moult,

but are retained and dissolved in the stomach. Their structure in the lobster, consisting of hundreds of small spicules, makes the solution of them possible in a very short time.

The gastroliths have been supposed to possess great medical properties and to perform a variety of functions, the most common and accepted belief being that they play an important part in the provision of lime for the hardening of the new shell. The small quantity of lime which they contain, however, not more than one one hundred-and-twenty-sixth of that of the entire shell, according to an analysis recently made by Dr. Robt. Irvine, shows that this is relatively unimportant. Fragments of lime, furthermore, are always at hand, and are frequently eaten by the soft lobster, shortly after ecdysis, in the adolescent stages at least. It is more likely that the gastroliths are the result of excretion of lime which is absorbed from parts of the shell to render moulting possible, and that their subsequent absorption in the stomach is a matter of minor importance.

**Rate of Growth.**—Larvæ increase in length at each moult (stages 3 to 10) from 11 to 15.84 per cent., or on the average about 13.5 per cent. (measurements from 66 individuals).

The increase in the young at each moult agrees quite closely with that seen in the adult, where the increase per cent. in ten cases was 15.3 per cent. Allowing an increase per cent. at each moult of 15.3—probably not excessive for young reared in the ocean—and assuming the length of the first larvæ to be 7.84 mm., we can compute approximately the length of the individual at each moult.

Length at	10th moult	28-23 mm.
"	15th	57.53 "
"	20th	117.24 "
"	25th	358.90 " (9.5 inches).
"	30th	486.81 " (19.1 inches).

According to this estimate a lobster two inches long has moulted 14 times; a lobster 5 inches in length, from 20 to 21 times; an adult from 10 to 11 inches long, 25 to 26 times; and a 19 inch lobster, 30 times. These estimates do not, I believe, go very far astray. We see them practically verified up to the tenth moult.

The time interval between successive moults is the next point to consider. Here the data are very imperfect. How long is the three-inch lobster in growing to be six inches long? Probably not more than two years and possibly less. This is supported by the observations of G. Brook. We therefore conclude that a ten-inch lobster is between four and five years old, with the highest degree of probability in favor of the smaller number.

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Adelbert College.

## FOSSIL LAND SURFACES OF THE SILURIAN.

By W. R. MACDERMOTT, M.B.T.C.D.

IN the common way, a fossil is a shell, a bone, a tooth, print of leaf, of footprint, of raindrop even. Up in a railway cutting near the mouth of a tunnel, whose far-off exit looks like a dollar out of one's reach, as dollars so often are in spite of the judicious efforts of Congress to make them as plentiful as blackberries in autumn, let us look for a fossil on a larger scale.

We begin, however, with what may be called a shell. Breaking away a bit of this thirty-foot high wall of coal black slate, we get what we want, a little golden saw. Opinions of course, differ as to the nature of this object. Our Irish peasant would say that it is the hidden treasure of leprachaun or fairy shoemaker (see "Standard Dictionary"), and had better be let alone, afraid it might be missed. Not concurring in this idea, the paleontologist calls it the fossilized chitinous case of a graptolite, an extinct zoophyte allied to the sertularia and virgularia of modern seas. In favor of the first opinion, it must be said that when we bring the thing home with us away flies its lovely gold. Nothing have we left but unmistakable brass and lead, proving past doubt that the fairies do not put up with such unscrupulous robbery.

Monograpus gregarius the unscrupulous thief, adding insult to injury, calls the thing let it turn what color it may. It tells us where we are geologically—somewhere in the upper zones of the Lower Silurian, in the Middle Silurian of some writers, somewhere near the horizon of the Utica slates of New York State. The numerous species of graptolites are the letters on the margin of the Silurian ledger, but the record here is so crumpled and tattered as to dismay the scientific bookkeeper. It is enough, however, for us to find ourselves in the Lower Silurian.

The top of the black cliff bristles over with formidable whins (Ulex europæus); the trails of a bramble (Rubus fruticosus) hang tangled down to its very foot through the arms of a cousin dogrose, bellicose in war paint and hooked thorns. When this Siluria cannot nourish these full-armed warriors it suckles poison in crevice and cranny, digitalis is its darling; when it cannot have its sweet pets it sulks and grows nothing at all. To study with whole skin we move on a bit. Here where the cliff falls away, level with our eyes, based on the rock and velveted atop with moss, a naked layer of yellow clay 18 inches thick is before us. Not all yellow; between the moss and clay there is a thin dark lamina of humus green line of moss, black line of humus and yellow band of clay. This is an existing land surface; note it well, for in its keeping is a great part of the world's history, and, unlike Sancho Panza, its way is to let secrets rot in its keeping.

From the middle of the clay band pick out yon bit of slate matted about with living roots. See, there is a mat of intersecting graptolites inside of it. Thus the dead zoophyte of a dead sea meets here the roots of ulex, a land plant living to-day. In the existing earth cap we have thus land life and sea life, the life of a remote past and that of the present time intermingled. And here, at least, time has no representation between the ancient and the modern life, or rather because time implies incessant action, no visible representation.

But this is the typical, the normal land surface; and as we find it so, we may expect to find ancient fossilized surfaces of the same kind. We may expect to find in them the older life of their rock base, as a rule marie and separated it may be by son of time, the

later life of rock disintegration, for the most part terrestrial.

There are other surfaces, but they are exceptional and secondary, the result of the denudation of the fragile primary layer of disintegration. Below us we see a little canyon in which a stream carries away the Silurian earth cap within its reach to lay down the waste elsewhere. Everywhere this Silurian district around us is riven with dikes of Miocene basalt and elvanite. In the distance between mountain ranges of granite, upheaved most probably in the Miocene age, we catch sight of a gleaming floor winding far inland. To it goes the waste of all—Silurian clay slate, Miocene basalt and granite—to be formed into new beds. Nevertheless, the average areal condition of the land cap, though seamed and broken in on in every direction, is given by what is before us, that is, it is simply the subjacent rock which has undergone a process of organic reduction, of what I called rock zymosis in a previous article in this journal.

The specific character of the slate rock is its lamination. This we will content ourselves now with stating as a mechanical, almost crystallographic character. It obscures almost entirely every trace of original condition in the rock. As slate disintegrates or may be disintegrated, some such traces may reappear. Here before us we see every gradation between compact laminated slate and pulverulent clay. In places half-decayed slate runs up into the clay, and seams of clay extend down into the rock. The resultant clay has a peculiar aspect of its own; it is granular, nodular, resolves into little blocks which fit nicely into one another. It often contains pebbles, sand and bits of conglomerate which must have existed in the original slate. But the process of decomposition must be very unfavorable for such survivals.

Look now at the thin layer of vegetable mould at the top of the clay—it is intersected in every direction with filamentous roots which carefully keep within bounds. The favorites of Siluria, however, travel far for their living, adventuring their straggling roots down even to the underlying rock. This interlacement of roots is a distinctive though very variable character of land surfaces. Sometimes—never here—the surface is black with humus and matted together with roots; at other times it is a pure mineral clay which even moss refuses to take to.

A little farther on we can find the slate entirely decomposed, but bearing no trace of modern vegetation. In this spot the rock, still the same black slate, is so rotten that we must be careful not to bring down the house on ourselves. The cliff slopes away to a pool to end in grimy ooze and mud caked and cracked. This mud is in perfect continuity with the richly graptolitic slate, but without any change of position; it has completely lost the mineral character of lamination. It is the rock undisturbed, but in the last stage of decomposition. The concealed palimpsest of the slate may be dimly traced in this black mud.

I will indicate how this may be roughly done without entering on details of the transliteration. Cutting away with a knife pieces of the paste or gathering rough blocks of it dry without baking them in an oven. Drop a piece of the stuff thus dried into a glass jar of clear water—at once in shades of gray and black pencilings we get a facsimile of the land cap we were looking at a while ago. As the lump crumbles away in the water, we see not only the peculiar packed granulation of the clay structure, but pebbles, some rounded, others angular; some distinct, others glued together in bits of natural looking conglomerate. Like the heroine in every good novel, their attitude seems firmness itself, only to astonish us by a sudden collapse. They are really as rotten as their surroundings, but in some cases I have managed to save them by a little manipulation from their natural weakness. We see penetrating among these and the nodules of clay black lines; sometimes blurred, sometimes quite distinct, representing the roots which traverse the modern land surface.

Often too we have black patches or blotches, reminding us of buried layers of moss or of underground fungi. I have some reason to think that some forms of the vegetation indicated lived in the soil rather than on it. This ancient Silurian surface was much richer in humus and carbonaceous material than its degenerate successor. The diffused blackness of these slates and shales points to a soil composed, to a great extent, of vegetable matter. The process whereby the modern soil is formed is attended with destruction of the old carbon trace.

It will be seen thus that this ancient Silurian clay slate, seemingly quite homogeneous, conceals an older form. That form is partially, at least, restored under some circumstances in nature and can perhaps be restored, too, by chemical processes. What the older form was in detail must rest for determination on experiment and observation; but as a preliminary I shall give some general considerations leading to the inference that it was primarily a land surface developed under the influence of vegetation, and as so developed became secondarily the subject of denudation in varied operation.

We take the typical land cap as simply the underlying rock undergoing decomposition without disturbance. As thus decomposed material, it is chemically altered; but we will pass over this primary step. When it begins to bear vegetation it undergoes further chemical change, which can be understood as a current phenomenon. For one thing, the rock debris becomes mixed with the results of vegetable decay; this we may pass over too. The important point is the action of vegetation on the rock material itself. From that material the growing plant takes up every leading ingredient, except one; it takes up lime, silica and potash and insoluble form, leading to their removal and dispersion in the long run. The one exception is alumina, which enters to no appreciable extent into the composition of plant tissue. The ultimate effect, therefore, of secular vegetation is the accumulation of alumina in the soil. Wherever the underlying rock thus contains alumina the overlying soil is relatively much richer in alumina, provided plant life has had time to produce its effect. Thus on the granite the soil becomes richly aluminous, although of the two ingredients of the rock containing alumina, feldspar contains only 18 and hornblende 7 per cent. In limestone soils the differentiation of alumina is even more marked. That substance is

stated as the base of soil, but it is plant life that makes it the base. In the coal measures it was secular plant life that in the course of time made the great "underclays" and rootbeds we see; these were not the cause nor the means of that life, but its effect and result. The same influence of vegetation in "aluminizing" the land surface we can see everywhere in operation at the present day.

If animal life were able to fix from the ocean the vast series of limestone and cretaceous rocks, we may entertain the idea that plant life by its negative operation was adequate to build up the slates and shales, and if in one geological formation, then in all. If we must give this Siluria here to the ocean and its beds of alumina to chance, we may give Monograptus gregarius, too, back to the fairies.

Poyntz Pass, Newry, Ireland, October 10, 1894.

#### A NEW STRAWBERRY.

RECENT number of the Gardeners' Chronicle, London, gives an account of a new variety of strawberry which had been sent for inspection by Mr. J. R. Stevens. The fruits are of a pale red color, lobulated and depressed, with a shining appearance and seeds deeply sunken. The flavor excellent; pulp solid and highly perfumed. The variety is considered a good one for early forcing. From the firmness of texture of the pulp, the Chronicle thinks it should make a valuable strawberry for market growers and others who are obliged to transmit their produce by road or rail. The foliage sent with the fruit was rather remarkable for its small size and short leaf stalks.

#### MOLASSES UTILIZATION IN CATTLE FEEDING.

OWING to recent changes in the legislation of European beet sugar countries, efforts are made to dispose

50 per cent. in weight of the fodder, of whatever elements it may consist.

A very important condition is that the molasses during mixing be sufficiently warm to thoroughly combine with the oil cake or beet cosettes, or whatever other product is used. When beet residuum is used, the fodder should consist of three pounds molasses and five and a half pounds of dried diffusion cosettes; the combination is complete in a few minutes, and should be then dried. If to be fed immediately to cattle, the mixing could be made as required.

Already on several European markets a product is sold for stock feed; its composition is 60 per cent. molasses, 40 per cent. cocoa oil cake (contains 20 per cent. protein, 3 per cent. fatty substances, and 25 per cent. sugar), which is sold for a fraction more than one cent per pound. Another fodder is composed of 20 per cent. cotton seed flour, 40 per cent. palm nuts and 40 per cent. molasses.

Several factories undertake their own mixing, and the substance obtained contains 14 per cent. protein, 3 per cent. fatty matter and 50 cent. non-nitrogenous matter.

In every case the results by feeding these rations to cattle have been most satisfactory; the percentage has increased. Satisfactory results have been obtained in fattening sheep with a molasses ration. It is important to note that an astonishing success has been obtained by adding to the water given to cattle about 2 lb. molasses per diem and per head; they seem to drink this with avidity, and beneficial effects follow.—The Sugar Beet.

[FROM THE Kew BULLETIN.]

#### SAGO CULTIVATION.

(Metroxylon Sagu, Rottb. Metroxylon Rumphii, Mart.)

THE sago of commerce is a kind of starch prepared from the soft internal stems of certain palms natives

after the seeds are ripened. The life of the plant lasts for about fifteen to twenty years, at the end of which period the terminal inflorescence is formed. In spite of the abundance of flowers, very few fruits are produced; these occupy two or three years in ripening. The propagation of these palms is usually effected by means of suckers or stolons formed round the base of old trees.

An interesting account of sago cultivation in Province Dent in British North Borneo is included by Governor Creagh in the report on the Blue Book of Labuan for 1893. [Colonial Reports, No. 122, Annual 1894.] As the subject has not hitherto been dealt with in these pages, the report, which has evidently been carefully prepared on the spot by Mr. J. G. G. Wheatley, is reproduced for general information:

#### A REPORT ON SAGO CULTIVATION IN PROVINCE DENT.

The sago palm, from which is manufactured the well-known sago flour of commerce, resembles in appearance the cocoanut tree. The former is valued for its trunk alone, the nuts are useless and the tree dies if allowed to fruit.

#### VARIETIES OF SAGO PALM.

1. There are only two kinds of sago palm which are cultivated, the "rumbia benar" (true sago) and the "rumbia berduri" (the thorny sago), also known as "rumbia salak." In appearance, both are the same, but on close inspection the stems of the latter, to which the leaves are attached, known as "pallapa," will be found to be covered with bunches of thorns about one and one-half to three inches long.

#### MODE OF PLANTING.

2. Sago grows chiefly on damp ground subject to floods at certain times of the year. If grown in swamps, less sago is produced and the trunks do not attain as great a height as when planted on clayey, damp soil subject to floods periodically. Once planted, the tree withstands floods and brackish water, but in the latter it does not grow as fast and the trunks are small. Sago is planted chiefly by suckers sent out by the parent tree, which are carefully cut off under ground. In swampy ground, the shoots are planted out at once, but in other localities the shoots are tied together in bundles and placed in wet, muddy ground until they have begun to send out roots, when they are planted out in holes twelve inches deep, one foot in diameter, and four to six fathoms apart. No earth is placed about the roots, but the plants are supported in an upright position by two sticks fixed on either side. The earth gradually fills the holes during rains and floods.

One man with an assistant can plant three hundred plants a day. After this, further attention is generally unnecessary for a year, and in some cases two years, when the jungle growth is cleared around the growing tree. Some planters regularly clear around the roots and cut away suckers if they are too abundant. Rumbia berduri is preferred to the rumbia benar, chiefly because the wild pigs do not attempt to destroy young plants, on account of the thorns. In planting rumbia benar, fences have to be made to keep out the pigs, which are very destructive. Rumbia berduri is also reported to produce more raw sago, but the quality of flour is the same in both species.

Each tree produces from four to five pikuls of raw sago (one hundred and thirty-three pounds = one pikul), being at the rate of one pikul per fathom of trunk. Both trees grow to the same dimensions, twenty-four to forty-two feet in height, and one and one-half to three feet in diameter at the base of trunk.

The sago palm is not subject to any disease, but, if a deep cut is made at the base of the trunk close to the earth, the pith is attacked by large maggots, which gradually eat their way into the center of the tree, and in three or four months destroy the whole trunk. This is a favorite way of paying off a grudge among the natives. The sago tree takes from five to seven years to mature, according to the nature of the soil. During the third year, the plant begins to send out shoots. These grow up with the parent tree and in time give out suckers. If these are allowed to grow too freely, they form a dense thicket around the mature trunks and give a great deal of trouble to the workers. Every year each clump produces a large number of workable trunks. During the fifth year, the parent tree is ready to be cut down. In the meantime, the young shoots are rapidly developing, and in the seventh year probably three or four trees are ready, and so on, so that the sago tree, once planted, continuously supplies the planter with logs without giving him any trouble as regards their cultivation.

The natives compare their sago plantation to a herd of cattle, and it would be difficult to reckon the number of logs that each clump may have produced in the space of forty or fifty years. When the sago tree is allowed to flower, the pith begins to diminish, and, if the mature trunks are not cut down regularly, the whole clump gradually deteriorates and the trees become stunted bushes, instead of growing to the usual height. Nothing of the sago tree is lost. The trunk supplies the sago; the leaves and stems are largely used by natives for building purposes, the former for roofs and the latter for partitions and walls of houses, which, when properly constructed, are very neat looking and durable. The top shoot makes an excellent vegetable, while the trunk, when split in two longitudinally and the pith scooped out, is used as a boat to transport the raw sago which has been extracted from it. The bark when taken off makes excellent fuel, and an enterprising Chinaman who employs an engine for rasping sago logs uses this as a substitute for fire wood.

The present price of sago flour at Singapore is \$2.55 per pikul. The Chinese traders buy the raw material at from \$1 to \$1.30 per pikul, according to the market price at Singapore, and, after allowing for the cleaning of the raw sago and washing it in the factories, there remains a profit of at least 50 cents per pikul to the Chinese manufacturers. The freight from Labuan to Singapore is 22 cents per bag of one hundred and fifteen catties = one hundred and fifty pounds. A royalty of 6 cents per pikul is charged on sago flour exported from Province Dent to Labuan when the Singapore price is below \$2.50, and 8 cents when above that



MR. STEVENS' NEW STRAWBERRY—COLOR PALE PINK.

of the residuum molasses to the greatest possible advantage. The idea of utilizing it for cattle feeding is not new, and has been practiced in many centers for twenty years past. Of late, however, the question has been discussed at the congress of the beet sugar manufacturers held in Dresden. When one considers the advantages to be derived, the great surprise is that it has not long since been generally adopted, as the economies resulting from the practice are numerous. Beet molasses contains a large proportion of the salts extracted from the soil by the beet during its development; and when fed to cattle and the resulting manure subsequently used, the fertility of the land is maintained for an almost indefinite period.

In many farming districts of France and Germany there prevails a natural prejudice against feeding molasses to cattle; and fact after fact pointing to the advantages to be derived seem to be of little avail. However, in the United States, but slight effort has been made toward convincing farmers of the importance of giving the subject a fair trial. To meet every possible objection that might be offered, the cattle-feeding associations of the country should take the matter in hand, and the results, we are convinced, would astonish them. We are pleased, from issue to issue, to record any attempts made. In the mean time we shall give herewith a few hints as to the best practices discovered and in what the most successful rations consist.

Some years since Prof. Maereker, after a series of extended experiments, concluded that the maximum of molasses to be fed per 1,000 lb. live weight and per diem was 3 to 4 lb. for oxen and 2½ lb. for milch cows. These limits have frequently not been adhered to, and many complications have followed. Of late it is urged that a special molasses fodder be used; it consists, besides the residuum, of some absorbing medium. In these compounds molasses frequently represents 60 per cent. of the total. Experts now say, however, that a far better proportion is to have one of molasses to one of the other substances, that is to say,

of the Malay Archipelago, Borneo, New Guinea and possibly of Fiji. The word sago or sagu is said to be Papuan for bread.

The are two well-recognized species of sago palms. The smooth or spineless sago palm (Metroxylon Sagu) is specially abundant in Sumatra and adjacent islands. It does not reach so far eastward as New Guinea. In North Borneo it is known as rumbia benar. Wet, rich soils, especially at the base of mountains, are its favorite localities. This species is regarded as the principal botanical source of the sago received in Europe.

The thorny sago palm (Metroxylon Rumphii) is found further east than the other species. It is plentiful in New Guinea, and in the Moluccas and Amboyna.

Both sago palms resemble each other in general appearance, but the latter is a smaller tree, and it has its leafstalk and the sheaths enveloping the lower part of the flower spikes armed with sharp spines from one-half inch to about one inch long. It has, moreover, decided littoral tendencies, and is abundant along the shores of many small islands forming a dense impenetrable belt. In North Borneo the thorny sago palm is known as rumbia berduri or rumbia salak.

Some sago is obtained from the sugar palm (Arenga saccharifera) after the plant is exhausted of its saccharine juice. The sago palm of India is Caryota urens.

The farinaceous part of the trunk of old trees is said by Roxburgh to equal the best sago from the Malay islands. In China, Japan and Florida, sago, differing in character of the starch grains from palm sago, is obtained from species of Cycas such as C. revoluta and C. circinalis. The commercial importance of the latter is very slight.

The cultivation of the true sago palms is entirely confined to the Eastern Archipelagoes. The plants are difficult to grow elsewhere, and it is improbable that the industry will extend beyond its present limits.

Both species of Metroxylon are monocarpic and die

sum. On raw sago, a royalty of 8 cents is charged to protect the sago factories.

The sago trade is increasing rapidly on the Borneo coast, and at the present time over three-fourths of the flour and raw sago exported from and imported into Labuan comes from British North Borneo ports.

(Signed) J. G. G. WHEATLEY,  
Mempakul, September 15, 1894.  
Magistrate, Province Dent.

#### NEW ELSWICK EIGHT INCH QUICK-FIRE GUN.

A RECENT number of the Engineer contains a description with illustrations of the above, which we quote as follows:

This piece, which is shown in Figs. 1, 2, and 3, is of wire construction, and it is provided with automatic breech gear. The power is very great. It is fired with cordite charges, giving a working muzzle velocity of 2,600 foot seconds to a projectile weighing 210 lb. In proof the projectile was fired with 2,800 foot seconds muzzle velocity. For armor piercing a shot weighing 250 lb. is provided, which fired with a battering charge has 2,670 foot seconds, and with a full charge 2,500 foot seconds, the energies being 1,306 and 10,890 foot tons, and the perforations through iron 29.0 and 27.1 in. respectively. As to rate of firing, a former pattern which was not fitted with automatic breech gear fired at sea from the Blanco Encalada four rounds in sixty-two seconds, the ammunition being supplied from the magazine.

The length of the gun is 45 calibers. The rifling is of the new Elswick pattern, and increases from breech to muzzle, the final twist being 1 turn in 33 calibers. The breech mechanism is specially designed for rapid loading, but cartridge cases are not employed, and the obturation is performed by a modified De Bange pad. The breech screw is "coned," being made in two diameters, with the largest diameter in rear, and the front portion is tapered. Owing to its form the breech plug may swing out directly the threads are disengaged, thus dispensing with the withdrawal movement required with cylindrical plugs. The action is slightly modified, however, in this gun, as in order to withdraw the De Bange pad from its seat, it is necessary to move the screw a trifle directly to the rear. The motion is combined with that of swinging out in such manner that it appears as one movement.

The screw threads are interrupted in five places—see Fig. 2—and the interruptions on the rear portion are checkwise with those on the front or tapered portion. The breech screw, therefore, engages with the gun throughout its entire circumference. The breech plug is borne on a gun metal carrier, and block sliding in the carrier carries a pin which engages in the rear face of the breech plug, and operates in such a manner that if the block is moved laterally, it revolves the breech plug. A link attached to a small arm carried by a worm wheel, which revolves on the carrier axis pin, is the means used to give lateral motion to the sliding block. The worm, gearing into the worm wheel, is carried by a shaft fitted with a hand wheel. The shaft is on the right of the gun—see Figs. 2 and 3—and the hand wheel is at a convenient distance in front of the breech screw. The man who opens the breech is entirely clear of the men who are engaged in loading the gun, and is in such a safe position when the gun fires that, even if holding the hand wheel, the recoil will not injure him.

Ten continuous turns of the hand wheel are required to open the breech, and this can readily be done in 3.5 seconds. The reverse motions for closing the breech occupy an equally short interval of time. In addition to the hand gear, the breech can be worked by automatic gear. If this is in action, the breech opens while the gun is running out, and after loading it is only necessary to pull a line for it to close again. The change from hand to automatic gear can be effected in about five seconds. Misfires sometimes occur with large guns when the primer is at the rear end of the breech plug and the vent is very long. To obviate this the primer is attached to a "primer holder," and is inserted about a foot into the breech plug, leaving only about 10 in. of vent between the primer and the charge.

The primer holder provides for either percussion or electric firing, and is so arranged that it can be easily inserted or withdrawn, and the gun cannot be fired unless the primer holder is properly placed. It consists of a steel needle inclosed by a tube of insulating material; outside of this is a steel tube, which in turn is surrounded by a strong spiral spring, which either keeps the striker in contact with the electric tube or serves to drive it against the percussion tube. The entire arrangement is contained in a steel case fitted in front with a short quick motion screw, on which the cap containing the primer, either percussion or electric, is screwed, and is centered immediately in front of the striker. The striker cannot be brought in contact with the primer during the operation of putting the latter in place, as the primer holder cannot be withdrawn from the gun unless the striker is drawn back and locked well clear of the primer.

Attached to a carrier is a trigger which may be put in gear for percussion firing or thrown out of gear when electric firing is used. If in the former position, it is only necessary to draw the primer holder to the rear to enable it to engage with the trigger, or if the gun is being loaded, the opening and closing of the breech performs this automatically. A lanyard may be attached to the trigger and worked from either the right or left of the gun. The cradle is made of steel, bushed with gun metal where it comes in contact with the gun. There are trunnions on the line about which the loaded gun and cradle balance, and special anti-friction gear is used to reduce the friction caused by elevating, so that the gun can be easily elevated or depressed by one man. The recoil press is underneath the cradle, the cylinder being bored out of a solid steel forging. A tank in communication with the cylinder contains a reserve supply of oil, so that there may be no risk of the cylinder becoming partially empty. Two running out springs are placed under the cradle, each in sections, so that in case of injury a spare section can readily be inserted. The springs can be removed from the mount in their compressed condition without difficulty. A bracket projects from the right side of the cradle, to which is fitted the sight, which is on the

"Elswick bar and drum pattern." Two side brackets which support the trunnions of the cradle are riveted to a steel platform which forms the upper roller path. On the right side there are brackets for the elevating and training hand wheels, which are conveniently placed for a man aligning the sights.

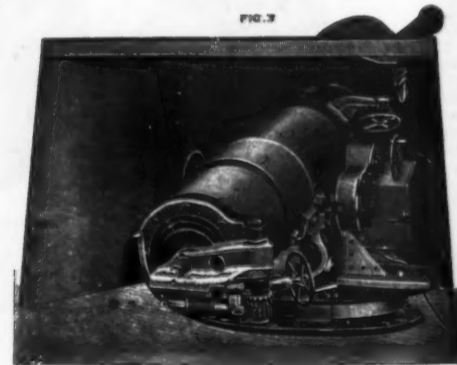
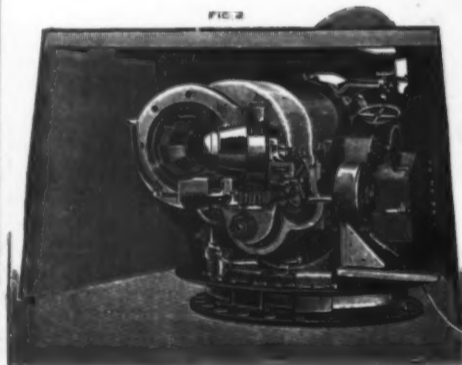
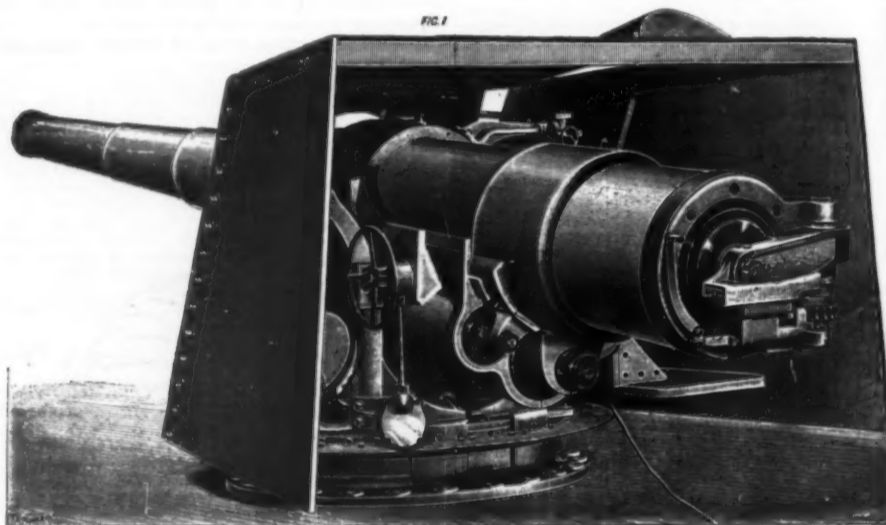
While the convenience of sighting with the right eye has not been neglected, some important advantages have been gained by placing the firer on the right hand side of the gun. The powder hoist is made to deliver the charge on the left side of the gun, and it can be served to the loader without being passed round the breech screw, which, when open, is on the right of the gun. This would be impracticable if the man who trains, elevates, and fires the gun were placed in the usual position on the left side.

The training gear of this mount can be worked by one man, although the revolving weight amounts to 42 tons; but the mounting is also fitted with electric training gear, on a most simple design. The man aiming manipulates the same wheel, whether training by hand or by electricity; only in the latter case there is no perceptible effort required. If the dynamo is not at work and hand training has to be resorted to, assistance can be given to the firer by another working a wheel on the left, which is coupled up with the training gear. The pistol for firing the gun by electricity is close to the elevating and training wheels. It is fitted with an electric sounder, so that each primer is automatically tested, and the firer is kept informed of the condition of the firing circuit. Another advantage of placing the firing position on the right side is, that the circuit is entirely on the same side of the gun as the hinge for the breech screw carrier, and a short and simple circuit can therefore be arranged.

clear of the armor plates. Before loading the projectile is placed in a tray provided with handles, which can be conveniently lifted by two men. The tray serves to protect the breech screw threads and guides, and guides the shot into the gun. A separate motion for sponging is rendered unnecessary by combining the sponge and rammer; but the sponging is made very efficient by a sponge head, provided with alternate rings of wool and bristles. The function of the former is to contain water, while the latter are secured at an angle so as to offer no resistance when the shot is being rammed; but which endeavor to stand up as the rammer is withdrawn, compress the saturated wool, and effectually sponge out the chamber. Although the electric firing system has many advantages, it is customary at Elswick to make such arrangements that percussion firing can be resorted to if necessary, and the transfer from one system to the other can be rapidly made.

Should a misfire occur, or should the electric sounder fail to ring when the gun is in the "ready" position, the spare circuit can be instantly connected by pushing a split pin, secured to the end of the wire, into a hole into the head of the striker; this will put the spare circuit in connection with the insulated pin, and cut out the ordinary circuit and battery. When the spare circuit is used it is necessary to fire with the McEvoy key.

The Elswick System of Breech Mechanism.—The breech screw is on the principle of the interrupted screw, but the forward portion is tapered, the rear portion being cylindrical. Two advantages are claimed for this arrangement: First, the working of the breech mechanism is greatly facilitated, as the withdrawal and bringing away of the breech plug can be done in



THE NEW ELSWICK QUICK-FIRE GUN.

The mount works on a ring of live rollers, protected from hostile fire by being placed at a lower level than the deck, and surrounded by a plate. Clips attached to the upper roller path, and hooked under the lower roller path, prevent the front of the mount from rising when the gun is fired. The shield has a thickness of 4 in.; but the sides of this shield are prolonged to the rear by 1½ in. plates, and the whole shield is so arranged that it balances about the axis of rotation of gun and mount. Special elastic attachments fasten the shield to the lower carriage, so that considerable distortion may be suffered without injury to the mount. Central loading is provided for in the case of the powder charge, but the shot are taken from racks placed close at hand. The powder hoist is capable of very rapid working. Two cages travel in it in such a manner that as one ascends, the other descends. The only weight lifted, therefore, is the weight of the charge, which is 52 lb. of cordite. By a simple shunting contrivance the cages pass each other in the middle of the hoist, and there is only one delivery orifice to the hoist for the two cages, this being on the left hand side of the mount. The cages can be hoisted by a quick-working hand winch, whatever the position of the mount. A door is formed at the bottom of the hoist, which can be inclined for supporting the cages when the charges are inserted.

Although the cages incline at the bottom of the tube for receiving the charge and at the top for delivering it, they are securely locked in a vertical position at all other times.

The hoist is well protected by armor plates, which are arranged so that certain plates can be removed in case the hoists require examination. The cages do not travel in close tubes, but in frames, which are well

one motion; and secondly, the coned shape enables the screw to distribute the engagement over a much greater portion of the transverse section of the gun. The breech screw is further arranged so that the threads of the coned portion correspond longitudinally with the plain spaces of the cylindrical portion and vice versa; thus the strain is distributed throughout the entire circumference of the breech screw. The breech plug passes on to the central projection of the carrier from the front, and is prevented from coming off by a bolt, which screws into the breech plug, and has a plain end fitting into a groove in the carrier, having the same pitch as the threads of the breech screw, and is of sufficient length to allow the bolt to be turned for screwing up the breech.

The gear is operated by means of a hand lever, on the lower side of the breech plug, which works in a horizontal plane. It pivots on the carrier, and is attached by a connecting rod to a sliding block. A pin in the breech plug works in a vertical slot in the sliding block, so that a horizontal motion of the latter causes the screw to turn. The centers about which the gearing works are on their dead points when the screw is closed, and it is therefore perfectly locked. When the lever is swung round it first unscrews and then brings away the breech plug, the two motions being combined so as to give the operator but one. The extraction in the larger rapid fire guns is arranged to take place in two motions. The cartridge cases are started by a powerful extractor, which has only sufficient motion to insure their being free for the remainder of the extraction, the conical shape of the chamber rendering a small amount sufficient for this purpose. The cases are then withdrawn and placed on deck by means of a hand extractor, which fits over

and firmly holds the primer. The mechanical extractor is worked by the carrier in opening the breech closure. It consists of a rod passing through one side of the gun, and fitting into the groove for the rim of the cartridge case, in such manner that when turned about its own axis, the fitted part acts as a lever and forces the cartridge case to the rear. A strong helical spring serves to return the extractor to place as the breech is closed.

#### THE NEW TELEPHONE SYSTEM OF PARIS.\*

In our first article, we have seen how the wires, starting from the dwelling of each subscriber, reach the corresponding central office and run up to the multiple switchboards. It now remains to show how the latter permit of putting the subscribers in communication at their will; (1) in the case in which they belong to the same office, and (2) when they are connected with two different offices.

We have not the pretension to describe in minute detail all the combinations of circuits, keys, commutators, jack knives, annunciators, etc., that permit of solving the problems involved in the putting of any two subscribers in communication, in all the cases that are met with in practice. Our sole pretension is to explain the difficulties, the question and the principles of the arrangements now adopted for giving an approximate solution of them.

The combination of the multiple switchboard is such that a telephonist can put herself directly in communication with any one of the 6,000 subscribers of the line ending at the office without passing through any intermediate one. To this effect, all the subscribers of the line, each of whom we shall designate in the future by the fixed number of his apparatus, are divided into groups of 240, which are repeated identically as to their arrangements. Fig. 1 gives the external aspect of one of these groups. Fig. 2 shows the groups as a whole as arranged in the Gutenberg Street office.

Let us consider, for example, group 1, which includes the subscribers from 1 to 240. This group is served by three telephonists, each of whom has in front of her 80 annunciators and 80 flexible cords corresponding to 80 subscribers. Each of these cords terminates in a spring jack that can be inserted in one of the 6,000 holes arranged in front of each group of three telephonists, and in six rows of 1,000 holes each. In reality, each telephonist has but 2,000 numbers directly under her hand, but the lengths of the flexible cords and the dimensions of each group are so calculated that upon extending her arm to the right or left, and in rising for the first hundreds, she can reach the holes corresponding to the telephone lines of the 6,000 subscribers.

It results from the explanations given that each telephonist is called up by 80 subscribers, who are always the same, and that it is possible for her to put each of them in communication with the 5,999 other subscribers of the same office. If she is at the center of the board, she takes the communication to the right or left with her own group. If she is to the right of the group, she takes the numbers included between 2,000 and 6,000 upon her own group and the numbers included between 1 and 2,000 upon the following group, which, by the very principle of the multiple board, presents no inconvenience.

It has been necessary merely to reproduce once more the general jacks from 4,000 to 6,000 upon the left of the first telephonist of the board and the general jacks from 1 to 2,000 upon the right of the last

telephonist in order to preserve the uniformity of the service and make it possible for the end telephonists of the board to call up the 6,000 subscribers without discommoding themselves. Each board division of 240 subscribers, served by three telephonists and capable of being put in communication with the 6,000

is opened, and such a circuit as may be desired is interposed—the telephonist's circuit for calling another subscriber's circuit, etc. The result is that the continuity of the line may be interrupted at 23 different points, and that in the subscriber's position of rest or waiting there are 23 contacts interposed upon the cir-

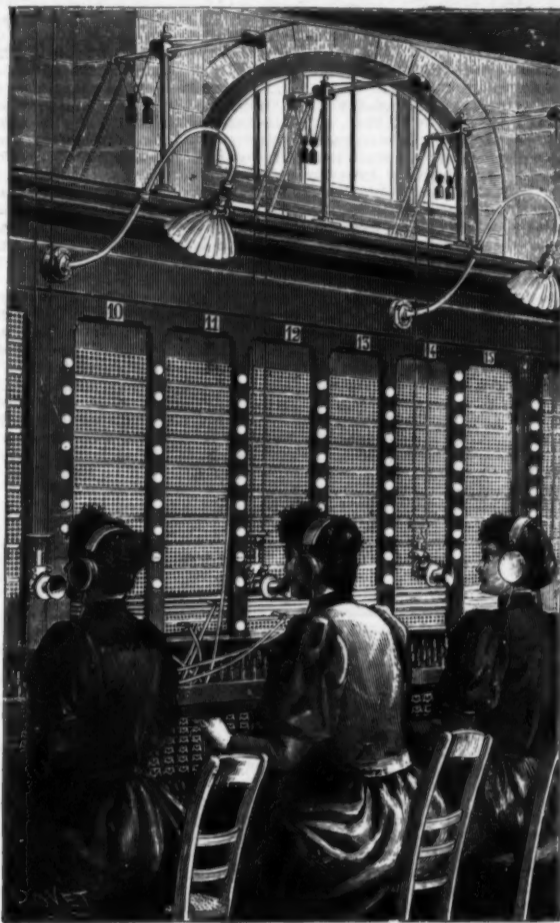


FIG. 1.—MULTIPLE SWITCHBOARD OF THE GUTENBERG STREET TELEPHONE OFFICE AT PARIS.

subscribers of the line, is 6½ feet in length and 5¼ in height, and is repeated quite a number of times—23 in the particular case of the Gutenberg Street office, and thus forms 23 distinct sections.

The double line of each subscriber thus traverses the 23 sections and terminates at the annunciator corresponding to the section. Through the introduction of a jack into one of the sections, the subscriber's line

is put in tension. A single bad contact suffices to immobilize the entire line, and herein lies the principal objection made to the multiple switchboard, whose general economy we are endeavoring to make understood without entering into the details of the communications, which would carry us too far.

From what we have just said, each subscriber always calls up the same telephonist, the one who serves his

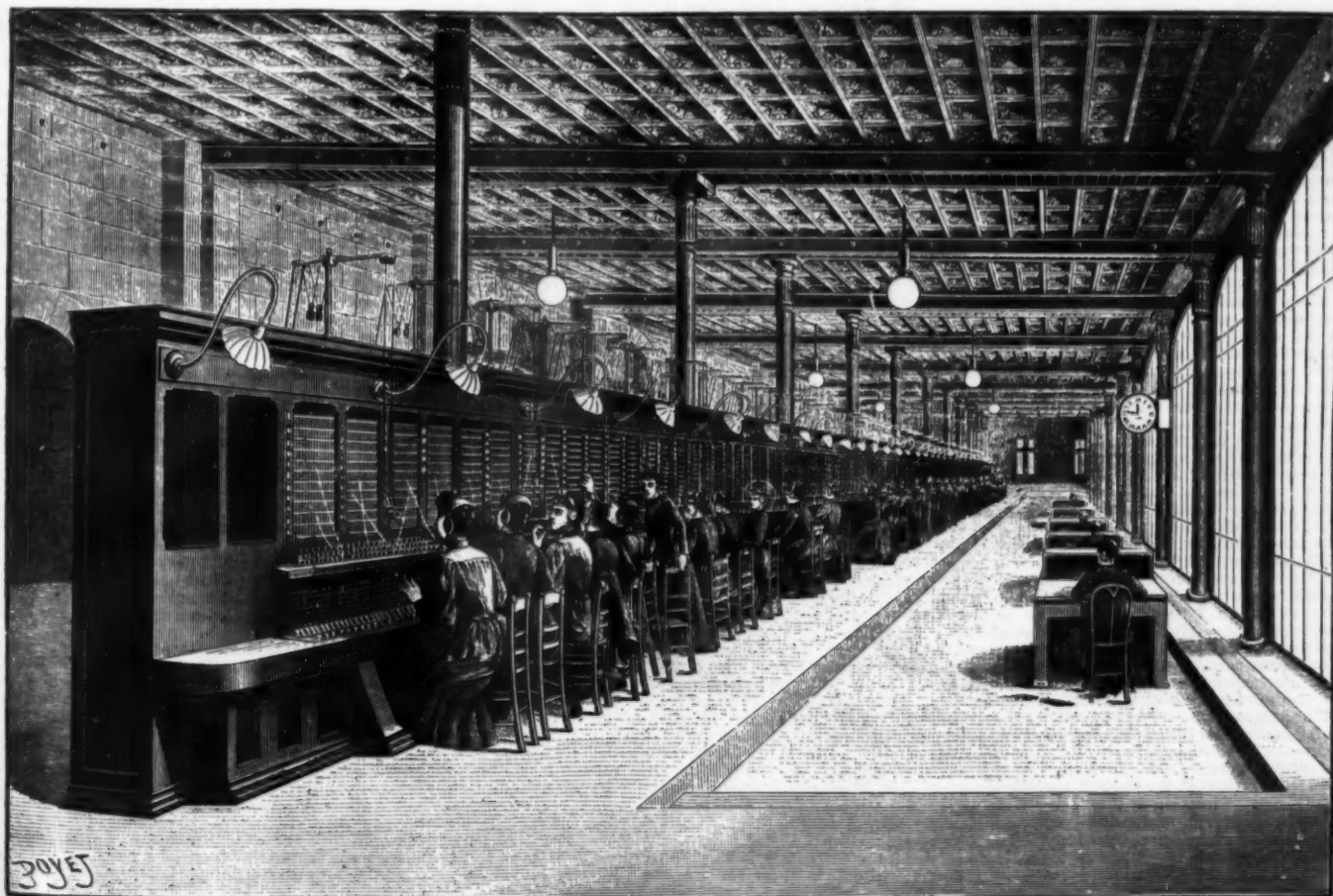


FIG. 2.—GENERAL VIEW OF THE GUTENBERG STREET TELEPHONE OFFICE.

\* Continued from SCIENTIFIC AMERICAN, January 26, p. 54.

section, and can be put by her in direct communication with the 6,000 subscribers of the same line. Such communication is made by the aid of a flexible cord, one of whose extremities communicates with the subscriber calling upon the board, while the other terminates in a jack that is introduced into the hole corresponding to the subscriber called up on the section of the person wanting him. But after the communication has once been established, it is necessary that it shall be interrupted after the conversation has come to an end.

In the multiple switchboard it is the telephonist of the caller who alone is informed as to the end of the conversation, thanks to a special annunciator interposed in the circuit of the flexible cord that she has used for putting the two subscribers in communication. When the two subscribers hang up their telephones and send the current of the battery into the line, the annunciator falls. The telephonist then pulls out the jacks of the flexible cord connected with the annunciator, and thus renders the two lines free, and replaces them in the position of rest.

The putting of any two subscribers in communication therefore sets at work only the telephonist of the caller, and never that of the person called, whose line may be occupied without her being aware of it.

It is necessary, however, to give each telephonist a means of knowing at every instant whether or not the line of one of the six thousand subscribers is in communication with another subscriber, that is to say, whether or not such line is disposable or occupied, since otherwise one would run the risk, according to the arrangement of the system, either of cutting off a communication already established or of putting in communication three subscribers whose relations—telephonic—are sometimes strained.

The indispensable information as to the occupation or non-occupation of a line is obtained very simply by the aid of the "trial key," the principle of which is as follows: When a line is unoccupied, it is electrically insulated from the ground and forms a complete metallic circuit without a contact of any sort with the earth or any source of electromotive force whatever. Under such circumstances, if any point whatever of such line be touched with a key connected with the earth with the interposition of a magnetic telephone, the latter will remain silent, since this contact with the insulated line will not cause any current to pass into it. The line is free, and the telephone gives an indication thereof through its silence. But if the line is occupied through the interposition of a jack, the latter is so combined as to put the point of the line in which the jack is situated in communication with the earth, but in interposing between the latter and the line a battery of a few elements. The entire insulated line is thus raised to the potential of the battery. If now a circuit be established between any point of this line and the earth through the interposition of the trial key and the telephone, the latter will cause a characteristic "click" to be heard that indicates that the line is occupied.

The telephonist of the calling subscriber obtains the information thus demanded as to the occupation or non-occupation of the line without discommodating the telephonist of the subscriber called and without her knowledge.

As may be surmised, it is the same telephone that serves the telephonist for hearing the subscriber and for verifying the state of occupation or non-occupation of the line of the subscriber whom it is desired to call. To this effect, the cores of the telephone are provided with two windings, one of which serves to indicate the occupation of the line, through the characteristic "click," while the other serves for the ordinary conversation with the calling or called subscriber.

**Telephone Apparatus of the Office.**—For the easy and rapid manipulation of the keys and jacks, the telephonist must have her hands free while listening to the subscribers, both in calling them and in answering them. To this effect, the microphone transmitter is suspended by two flexible cords that pass over pulleys fixed to arms mounted upon the upper moulding of the switchboard (Fig. 1). These microphones are balanced by counterpoises and remain at the level at which they have been placed on raising or lowering them by hand, so that the telephonist can perform her duty while seated or standing, just as she wishes, and adapt the position of the mouth piece to her stature. The microphone itself, which is of the Hunnings system, does not differ in principle from the granular carbon apparatus of which one of the first types was devised and brought out by Mr. D'Arny. Its sensitiveness is such as to allow the telephonist to speak in a low voice, and nothing is more curious to one who has visited the stations of the old system than to compare the true silence that reigns in a modern office during the hours of telephonic activity with the insupportable chatter that characterized the old offices. The receiving telephone, which presents no special feature, is held against the telephonist's ear (right or left, at her choice) by a light flat steel spring curved to fit the top of the head. The weight of the entire apparatus does not exceed four and a half ounces.

**The Putting in Communication of Subscribers who do not belong to the Same Office.**—In describing the Gutenberg Street office as established for 6,000 subscribers, we have said that the large switchboard comprises but 23 sections, which, in the proportion of 240 subscribers to the section, represents but 5,520 subscribers, while there are 6,000 holes in the complete board. The 480 other holes serve for the auxiliary lines connecting the various offices with each other and for the secondary services, upon which we cannot here dwell. When a subscriber requests communication with another subscriber not belonging to the same office, such communication is established by having recourse to auxiliary lines. To this effect, there have been established auxiliary outgoing lines and auxiliary incoming ones. The former serve each telephonist for calling the other offices, while the latter, on the contrary, are used by the other offices for calling that of Gutenberg Street. The outgoing lines of one office are therefore in reality the incoming ones of the other office at which they end, and reciprocally. The adoption of a single direction of call for each auxiliary line effects an important simplification in the service and in the apparatus.

**Suburban and Interurban Communications.**—The interurban communications form a less extended sys-

tem as regards the number of subscribers. They are established in a special office in the entresol of the Hotel des Telephones and occupy a switchboard that is not so large as the multiple one of the first story reserved for city communications. The communications between the subscribers of the system and the suburban or interurban lines are established by the aid of a special switchboard which precedes the section boards of the city service and which has the effect of directly switching the line of an office subscriber upon the interurban lines without passing through all the sections of the board, so as not to introduce into the long distance line the prejudicial capacity of all the wires of the multiple board. A subscriber thus switched on to the interurban line becomes isolated from the city one, but the key serving to effect such switching puts all the jacks in communication with the ground and a battery, in order that the telephonist may be notified of the non-disposability of the line voluntarily switched on to the interurban one when the subscriber is called, and that the calling telephonist may test the line, in order to assure herself of its state of occupation.

From what we have just said may be surmised what an enormous number of wires is used for a multiple switchboard for 6,000 subscribers, and the number of connections to which it gives rise. There are more than a hundred to the subscriber, and, in taking into account the auxiliary lines, suburban and interurban, we have more than a million. There suffices but a single bad connection to immobilize a subscriber's line. A bad contact, a break, or a poor insulation of the line wires produces the same result. A subscriber whose battery is exhausted or broken can no longer call up the central station. If he has forgotten to hang up his telephone, the central office can no longer call him up.

Taking into account the great complication introduced into the exploitation through the absence of call by number—the only logical and rapid system—it is now explainable that the telephonic communications undergo delays or interruption for which the telephonist or the administration, which can do nothing in space, is too often held responsible.

We cannot too often repeat the statement that the difficulties are great and that the incessant evolution of telephonic apparatus is not yet going on quickly enough to respond to the continuously increasing exigencies of a perfect service.

As yet we have said nothing of the Hotel des Telephones, in which is installed the entire service, whose broad lines we have just indicated.

This building, constructed back of the Post Office, between Jean-Jacques, Rousseau and Louvre Streets, and fronting on Gutenberg Street, occupies an area of 15,000 square feet. It constitutes a genuine type of modern construction, light and elegant, and forming an edifice largely of glass, into which pour floods of light and air.

The cellars serve for the entrance and distribution of the wires, the ground floor is reserved for the station service wagons, the first story for interurban communications, the second for the city service, and the third and fourth are reserved for future extensions.—E. Hospitalier, in *La Nature*.

(FROM THE OUTLOOK.)

#### NIKOLA TESLA AND THE ELECTRIC LIGHT OF THE FUTURE.

By WALTER T. STEPHENSON.

EXACTLY ten years ago Nikola Tesla, who, in June, 1894, received high honorary degrees from the colleges of Yale and Columbia, came to this country, poor and unknown, to enter an Edison shop in New York City. For two years previous he had served as engineer in one of the new electric lighting companies in Paris, and, having become an ardent and appreciative admirer of the splendid genius of Thomas A. Edison, whose fame in those days had only recently flashed throughout Europe, he was, naturally, eager to accept an opportunity of meeting the "wizard" face to face.

Tesla had already patented several minor inventions of his own, but, what was of more importance, his brain was then literally teeming with great ideas, as yet, perhaps, chaotic, but which must some day evolve into definite shape for revelation, and of all countries he firmly believed the United States offered the best encouragement to the inventor who could show practical results. Since New York has continued to be Mr. Tesla's home, we may reasonably infer that he has not been disappointed in his early expectations.

The young Serbian electrician derived a fresh stimulus and lasting benefit from his association with Thomas A. Edison. Nevertheless, he soon realized that it would be far wiser for him to continue his special investigations alone, unhampered by other work. Therefore, after a few months of delightful intimacy, the two men of genius separated with mutual expressions of good will.

Mr. Tesla now threw himself with redoubled ardor and energy into the study and analysis of alternating or polyphase currents, which had long been his chosen field of electrical investigation. In 1887 he exploited his wonderful invention of the rotating magnetic field for the economic transmission of power. This simple statement means that, after thirteen years of indomitable effort, embittered by sore disappointments and fierce controversies, a substantial success was at last assured, while scientists everywhere began now to await with keenest interest succeeding developments of the potentialities undoubtedly latent in these hitherto neglected alternating currents.

The majority of us probably are aware that the principal electricians of the world have long been struggling vainly toward the solution of a tremendous problem—the improvement of the electric light. When we are told, for one thing, that fully ninety-nine per cent. of energy is wasted every time such artificial illumination is produced under existing conditions, we begin to realize the crying need there is for a radical change in industrial methods. Now, the goal which some electricians declare to be already in sight means nothing less than the recovery of fully one-third of this wasted energy, thereby rendering possible an illumination many times brighter than at present and at a notable reduction of expense. The question is,

Which one of the few leaders in the race will outstrip the others and win an immortal name?

Rumors have reached the public ear with increasing frequency of late that Nikola Tesla was working slowly but surely in his own way toward the accomplishment of some such magnificent end.

We know that in May, 1891, Mr. Tesla emerged from the seclusion of his laboratory to deliver an address before the American Institute of Electrical Engineers, at Columbia College, on polyphase currents as applied to artificial illumination. Having in this lecture created a marked impression by the lucid exposition of his peculiar theories, he was soon urged by some of the prominent scientists of Europe to favor them in like manner. So it was that in February, 1892, he crossed the ocean and lectured before numerous audiences in England and on the Continent. It is not too much to say that the name of Nikola Tesla now commanded universal attention in the world of science, but still the man himself was beginning to chafe sadly already under his prolonged absence from the distant laboratory. In the fall of 1892, therefore, he gladly returned to New York to resume his interrupted labors in behalf of science.

In view of all this, even the hardest of interviewers would be apt to think twice before intruding upon such an individual in his privacy. It will be enough, perhaps, for me to say that the forbearance and kindness of Nikola Tesla are by no means his least distinguishing traits. Not very far from Washington Square, in the heart of that picturesque neighborhood known as the French quarter, teeming with cheap restaurants, wine shops, and weather-beaten tenements, the observant passer-by will notice a huge yellowish brick building of some half-dozen stories apparently devoted to manufacturing purposes.

If such a one should undertake to explore the murky interior of this uninviting looking pile, say to the extent of climbing three or four flights of stairs, and warily threading a signless path through successive mazes of vociferous machinery, his perseverance might be rewarded, as in my own case, by discovering the retreat of a modern wizard. While awaiting my opportunity in an anteroom, I caught glimpses through the adjoining office and library of the mystic laboratory itself, which, as I ascertained later, opened into an immense machine room.

I may candidly state that I was a trifle shocked the first time I saw Nikola Tesla as he suddenly appeared before me in the library and sank into a chair seemingly in a state of utter dejection. Tall, straight, gaunt, and sinewy of frame like a true Slav, with clear blue eyes and small, mobile mouth fringed with a boyish mustache, he looked younger than his thirty-seven years. But what arrested my attention chiefly at the moment was the pallid, drawn and haggard appearance of the face. While scanning it closely I plainly read a tale of overwork and of tremendous mental strain that must soon reach the limits of human endurance.

"I would like to talk with you, my dear sir," he said, "but I feel far from well to-day. I am completely worn out, in fact, and yet I cannot stop my work. These experiments of mine are so important, so beautiful, so fascinating, that I can hardly tear myself away from them to eat, and when I try to sleep I think about them constantly. I expect I shall go on until I break down altogether. So you would really like to see some of my experiments in electric lighting," he added. "I shall endeavor to accommodate you, my friend, if you will come with me into the laboratory. Be prepared, though, for a surprise or two."

Mr. Tesla then ushered me into a room some twenty-five feet square, lighted on one side by two broad windows, partially covered by heavy black curtains. Directly opposite was an open door leading into the machine room, which seemed to be fairly alive with grimy figures flitting to and fro. The whole scene, to my unaccustomed eyes, suggested a veritable magician's den.

The laboratory was literally filled with curious mechanical appliances of every description. Wires innumerable, from the smallest size to cables three-quarters of an inch thick, ran along the walls, ceiling, and even the floor. In the center was what appeared to be a large circular table covered with thick strips of black woolen cloth; snakelike cables running up underneath were connected at the other end with an adjacent dynamo, thereby establishing a possible center of electro-dynamic vibration. Between the table and the windows two large brownish globes, eighteen inches in diameter, depended from the ceiling by cords. These balls were composed of brass, coated with two inches of wax to render them non-injurious, and served the purpose of spreading the electrostatic field.

So much for my surroundings, as I glanced about in some bewilderment after hearing Mr. Tesla say that he had a surprise in store for me. Promptly suiting the action to the word, he called in several employees from the workshop and issued a succession of hurried orders which I followed but vaguely. Presently, however, the doors were shut and the curtains closely drawn until every chink or crevice for the admission of light was concealed and the laboratory bathed in absolutely impenetrable gloom. I awaited developments with intense interest.

The next minute exquisitely beautiful luminous signs and devices of mystic origin began to flash about me with startling frequency. Sometimes they seemed iridescent, while again a dazzling white light prevailed.

"Take hold," said a voice, and I felt a sort of handle thrust into my hand. Then I was gently led forward and told to wave it. On complying, I spelled the word "Welcome" flaming before my eyes. Unfortunately, I was totally unable at the time to appreciate the kindly sentiment implied.

A hand approached mine ere I had quite recovered, and I felt the tips of my fingers lightly brushed. Fancy my dire dismay when I immediately experienced an acute tingling sensation, accompanied by a brief pyrotechnic display that was surprising, to say the least. When the daylight, as well as my equanimity, was in a measure restored, I learned something of the meaning of these wondrous experiments, which may be said to foreshadow in a way the electric light of the future. What impressed me most of all, perhaps, was the simple but cheerful fact that I remained unscathed while

electrical bombardments were taking place on every side. Curiously enough, the polyphase currents of high frequency and high potential, of say 200,000 volts, have, as Mr. Tesla has demonstrated repeatedly on the platform, no harmful effect whatever on the human body, although a like energy exerted in indirect currents would prove instantaneously fatal.

Over two and a half years ago Mr. Tesla made this striking observation in one of his lectures: "The ideal way of lighting a hall or room would, however, be to produce such a condition in it that an illuminating device could be moved and put anywhere, and that it should be lighted no matter where it is put, and without being electrically connected to anything."

To return to my own experience in the darkened laboratory, it seems that the entire room was actually filled with electric vibrations through the agency of these same currents, styled alternating (that is, with direction perpetually changing). The strange devices I had seen were nothing more than nearly exhausted glass tubes bent into various shapes and analogous to lamps, excepting that they were devoid of filament or batten.

These tubes being carried into the area where the electrical agitation was strongest, the remaining molecules of ether or air within all the while pressing against the crystal confines, a molecular bombardment followed, produced by the collision of two forces, and the bulbs simultaneously became luminous. Those which were made to glow with the colors of the rainbow were coated on the inside with phosphorescent substances.

I have attempted nothing more than a very imperfect outline of Mr. Tesla's novel and interesting scheme, which is to be regarded as still in a state of embryo. It cannot be denied, too, that there are many scientists to-day who shake their heads dubiously at the brilliant Serbian's unequivocal attitude toward the electric light.

Meanwhile Mr. Tesla makes no boasts, but is willing to abide his time. Throughout the interview I was constantly impressed with the man's loftiness of purpose, innate modesty and utter indifference to public applause. "I should much prefer not to be written about at all," he remarked; "but if it must be done, I trust you will take due pains to quote me correctly."

Speaking of the scientific status of the United States as compared with that of other nations, he said: "English scientists are the greatest in theory, perhaps, although, as far as practical results go, America may well claim to lead the world. That is why I like to stay here."

Mr. Tesla speaks our language with the idiomatic range and choice diction of a native who is also a scholar and a trained speaker, the guttural accent of the Slav, of course, being slightly noticeable. He told me that he felt equally at home in six languages, not to mention the same number of dialects.

Though simple, self-contained and undemonstrative in manner, when he is especially pleased or absorbed in enthusiastic description of electrical wonders, the intellectual animation of his frank blue eyes, combined with a rarely winning smile, exercises a charm that is irresistible. I have noticed the same unconscious quality of personal magnetism in Mr. Edison, though in almost every other respect these two remarkable individuals are totally dissimilar.

Edison may be more truly the man of genius. He works out his intricate problems by intuition. He peers into the future like a seer of old, and receives, as it were, lightning flashes of inspiration to guide him to the goal. In a word, the illiterate train boy of thirty-odd years ago has come to be regarded as little less than a wizard; and yet, assuredly, he is neither a thinker nor a student in the true sense.

Now, how is it with the Serbian, who has acquired fame much less rapidly? What was his life before he came among us? Let me say, at the outset, that eighteen years of exhaustive, patient study were accomplished before Nikola Tesla deemed himself adequately prepared to embark upon the career which he had planned from childhood.

Born in 1857 at Smiljan Lika, a remote village in Austro-Hungary, he is the descendant of a sturdy line of Serbian patriots, who for centuries had taken a prominent part in the protracted struggle against the domineering Turk.

The young Nikola commenced his studies in the public school of Gospich when five years of age. Not long afterward the marvels of electricity and magnetism began to dawn upon the boy's receptive soul. Fascinated and stirred until he scarcely thought of anything else, he resolved thenceforth to devote his life to research and investigation in this noble field of knowledge. In 1873, against the wishes of his father, who, being a clergyman in the Greek Church, had hoped that his son would discover a theological bent, Nikola entered the Polytechnic School at Graz. It was at this institution, while puzzling over the complexities of a direct current Gramme machine, that his alert mind was led to conceive of a rotating magnetic field, which discovery was destined to deal the death-blow to those troublous contrivances the commutator and brushes. After completing the technical course at Graz, Mr. Tesla removed to Vienna, where for several years he attended philosophical lectures, read omnivorously on many subjects, continued his special studies, and incidentally found time to master five or six languages. Verily, an intellectual training of this sort, in the face, too, of untold trials and difficulties, would have far exceeded the scope of any ordinary student.

Before I bade a regretful farewell to this kindly wizard of Washington Square he confided to me that he was engaged on several secret experiments of most abundant promise, but their nature cannot be hinted at here. However, I have Mr. Tesla's permission to say that some day he proposes to transmit electric vibrations through the earth; in other words, that it will be possible to send a message from an ocean steamer to a city, however distant, without the use of any wire.

To those who would gain a complete technical knowledge of the Serbian's manifold labors since he came to the United States I would recommend a careful study of the volume recently issued by Mr. T. C. Martin, of the Electrical Engineer, entitled "The Inventions, Researches and Writings of Nikola Tesla." How strange it is, indeed, that, though electricity has so

long been partially controlled by mankind, yet we are utterly unable to define it! As Mr. Tesla has said: "The day when we know what electricity is will chronicle an event probably greater than any other recorded in the history of the human race."

[FROM THE ASCENTIAN.]

#### HEALTH AND ATHLETICS.\*

By Sir BENJAMIN WARD RICHARDSON, M.D., F.R.S.

##### EFFECTS OF SPECIAL EXERCISES.

I AM led now to refer to certain special exercises and sports in their effects upon the health of the body, and in this direction I shall follow a division instituted by a recent most able writer, Professor Kolb, who, in his book on the "Physiology of Sport," has made a larger number of correct observations than any other writer with whose work I am acquainted. Kolb, himself a sportsman, mixing largely with sportsmen, gaining their confidence, observing their modes of life, and bringing to bear in his researches the finest instruments of precision, has brought the physiology of sport almost to mathematical demonstration. He divides the effects of sports into a series of classes. (1) In the first class he refers to physical acts, during which particular groups of muscles are actively moved until they become affected, but without interference of a serious kind with the functions of the other organs of the body. (2) Exercises in which the breathing or respiratory system is exceptionally affected. (3) Exercises in which the motion of the heart and the circulation is primarily and most distinctly concerned. (4) Exercises in which the nervous system becomes particularly influenced, and in which that system is reduced in power or worn out by efforts of too severe a kind.

The exercises which influence the muscles purely, and which may be classified under the first head named above, are such as cause the muscles to move without serious change in regard to the position of the body on the surface of the earth: lifting weights, working dumb bells, and bell ringing are examples of this sort. The body moves but does not progress. Kolb puts this well in the following way: "Let a strong man take a pair of dumb bells weighing about fifty pounds each, and move them from his chest upward by stretching his arms. A man of common strength cannot do that at all; our experimental man may be able to do it ten, twenty, or thirty times; at last, however, the muscles refuse, that is to say, he can no longer move up the weight against the force of gravity. If we examine the man's pulse and respiration soon after, we observe the rate of his heart beats to be certainly fast, being about 100 to 120 per minute; his respiration, too, is strong and deep, about 25 times a minute; but neither his heart nor his lungs are strained at all. The muscular pains, however, that remain for days, and the feeling of lassitude, prove distinctly that the muscles have failed." All games of this nature produce the same effect. In young gymnasts who are practicing climbing movements, in men who are beginning to learn what is called the art of self-defense, in men who are learning sword exercise, this same condition of wearied muscles occurs, and in all such cases it is bad practice to keep up the exercise until actual muscular fatigue is developed. Nothing, in fact, is gained by overwork in this direction, for muscle is apt to get overstrained, and to lose that flexibility as well as strength which is essential for its perfect action. The golden rule here is that so soon as a muscle or group of muscles begins to be weary it is time to leave off action, for muscles should never feel pain in action, pain in movement of muscle being the most certain index that rest is immediately called for. Exercises of another kind belong to the second class named above, and affect primarily and indeed chiefly the muscles of respiration, the breathing muscles. Rowing, of which university men are so fond, is of all exercises the one which affects respiration. You will see a crew that has not yet been trained go out for active exercise, and as they get into the full swing of the work you will notice, if you are careful, how powerfully the breathing is affected. The breathing, you will see, is rapid; there is a sort of bluish pallor in the lips and face, and even when the act of rowing is stopped there is an out-of-breath condition which is felt, more or less, by all who have been doing the same work. Of course there are always differences in different rowers according to the build of the body. The man with a good large chest, and the tall man, the man who by a spirometer can show from 250 to 300 cubic inches without fatigue, will be infinitely less breathless than the man with a small chest and short body, and who can blow only 200 to 250 cubic inches; but, more or less, all will suffer, and the great danger of rowing lies in injury done to the respiration in the first instance. If I were to select from a body of young men, promiscuously brought together, those who were best for a rowing match, I could, by proper measurement of the breathing power, of the height of the body, of the size of the chest, pick out almost without question those men who would make, in the end, the best crews, although at the time not one of them had become trained to rowing practice; and this, I think, what ought to be done in the selection of crews for great competitions, since it is very bad for a young man even to train into a practice which by excessive exercise shall impair the function of the lungs. I do not say this from any prejudice, and I do not wish to exaggerate in the least degree. The disease emphysema—that is, rupture of the air vesicles of the lungs—which some think they have noticed as consequent upon rowing, I cannot say I have ever seen, and it is but honest to add that I have known an improved development of the breathing organs and of the capacity of the chest induced by moderate rowing. What I have seen, and what I would warn against, is an effect of rowing which shows itself in a persistent difficulty of breathing during the exercise, and which is followed by some shortness of breath in other efforts, such as walking and riding, playing at tennis or cricket, and such like exertions. Rowing, moreover, when it affects the breathing, is liable, secondarily, to cause disturbance of the circulation. The position of the rower in the boat is peculiar. His lower limbs are to a considerable extent fixed; his body is bent forward, and then strongly backward.

the chest being kept in full tension. During these acts there is a considerable strain thrown upon the valves of the heart. The blood which has to course over the arteries from the heart must ascend, before it makes its way anywhere over the body; ascends over what the anatomists call the aortic arch, and be prevented from going back into the heart on the left side by three valves, which allow the blood to come forth from the center, but which, falling down, check it from being returned. But in the motion of rowing with the lungs charged with air, the blood rising through the arch is, in a sharp degree, thrown back upon the valves, much as occurs in water falling back on a tap, to which we give the name of the water hammer. So I have observed that in a man who has been briskly rowing, the second sound of his heart, which is produced by closure of the three valves, is often accentuated, owing to the sudden pressure exerted by the column of blood. Now this is a very considerable strain. By the influx of blood the heart is made to work more laboriously; it has an extra pressure put upon it; it is quickened in its action, and the great elastic blood vessel, or aorta itself, is unduly distended. So in rowing men, there occasionally follows disturbance of the heart as well as of the breathing. The heart becomes unduly large and over-active, a state for which, in order to obtain recovery, the injured person may have to lie in a recumbent position for several months, and from which possibly he never entirely returns to health, but has an excitable state of the circulation when he is subjected to any particular strain or mental worry. Rowing, therefore, although a fine exercise, requires to be carried on with some prudence, and while I have not a word to say against it, but indeed very much enjoy the sight of it in a good contest, it is, I should like to intimate, an exertion which should never be persevered in if the signs of embarrassment, first of the respiration, and secondly of the circulation, are clearly felt and detected by those who practice it, for I doubt if there is any going back to health in the strict sense of that term, when such signs are definitely pronounced and for a long time maintained.

The exercises or games which affect the circulation, and which come under the third head, include running, cycling, dancing, and football. The first of these sports—running—I cannot say much for from a health point of view; indeed, I am obliged to speak adversely in respect to it. Man was not constituted to be a running animal, and the irritability of the circulation induced by sharp running exceeds everything that would be expected of it. You are all aware that a runner on first setting forth has got to get what is called his wind. He seems to be stopped by the fact that he cannot breathe fast enough; he pants for breath, and it is some time before he gets over this difficulty. The fault is not in the breathing organs, however; it is in the circulation. In order that a healthy feeling may be maintained, in order that there be no oppression, the balance of the circulation and the respiration must be properly set; the heart must send forth the proper quantity of blood that the breathing can supply with oxygen, or else the heart, sending over blood too rapidly, the breathing must be increased so as to adapt the one function to the other. If, therefore, the heart be set going at an unusual rate, and beyond the relationship of the breathing power, the balance is broken and "the wind," as the common saying goes, is imperfect or deficient. In running the balance is disturbed, owing to the sudden rapidity of the heart induced by the exercise. Supposing the natural beat of the heart to be about 75 in the person commencing to run, if he run briskly one minute, the circulation will go up to as much as 200, and at two minutes it may reach the incredible rapidity of 250 or even 260 beats per minute. But the breathing, which in a natural state would be about one to four of the pulse, ought under these circumstances to increase proportionately, that is to say, the breathing should rise to 50 or even 60 per minute; but this it cannot do immediately. It cannot rise with proportionate rapidity to the heart, and some time has to elapse before it reaches that maximum; so the runner has to wait to gain his wind, and then he can go on for a considerable time. When he comes to a stop, a new order of things prevails. The heart has become fatigued with the effort, and, instead of falling down leisurely to its natural stroke it intermits—that is to say, there are four or five rapid beats of the heart and then a stoppage, followed by another series of quick beats, and again a stoppage, until equilibrium is obtained. Under this condition the breathing comes down to natural action more steadily than the pulse, and most, if not all, runners are obliged to hold their breath at intervals, in order that the breathing may not be too rapid for the heart. It is fortunate that the breathing is, to some extent, under the power of the will, so that the accommodation can be met by a voluntary effort; if it were not so, fatal accidents after running would be exceedingly frequent. On the whole, running carried to competition is, as you must see, a dangerous exercise. I have known very bad effects indeed from it, telling always on the circulation. The heart becomes enlarged, and, more than that, it becomes irregular, which is a very bad state for those who suffer from it. I have, in fact, never met with a man who practiced running for a long time who had not an irregular circulation or an intermittent one, and in whom the heart was not very irritable or very enfeebled; nor do I think that perfect recovery from this injury to the circulation is ever actually witnessed. I should, had I my way, exclude running from all athletic exercises.

Cycling has something of the same effect as running—that is to say, it tells upon the circulation. In a very short time, during rapid cycling, the heart is brought into extreme action, the beats of it rising under great pressure to 200 or even 250 per minute; and when the active career of the over-enthusiastic cyclist is shortened, with the occasional collapse of a man in full exercise, the fact is due generally to the overwork of the heart. I have for many years past been cautioning cyclists on this matter. I have been criticised for my pains, and have even been charged with doing injury to the exercise by the advice I have given; but I have never had any reason to change the line I have pursued in this matter, my very love for the pursuit giving an impetus to the emphatic way in which I have dealt with it. It has been a hard fight for me to offer opposition on this subject; it has been a clear task to predict consequences; and I regret that far too

\* Lecture delivered before the Shaftesbury Club, Oxford, in the Clarendon Room, March 3, 1894.

Continued from SUPPLEMENT, No. 1003, page 10035.

often the predilections I have made have been too faithfully fulfilled. Still men go on, and it is my duty once more to take this opportunity of warning men of all ages not to give up cycling, for that would be the greatest pity, but not to overstrain at it. Long and severe competitions of cycling, in which the exercise of full speed is kept up for many days, may excite the admiration of lookers-on who sympathize with the sportsman; but there is a certain end to it in derangement and disease of the circulation, which is inevitable. The heart gets unduly active, the arteries become unduly distended, the elastic tissue of the arteries, and of the body generally, loses its spring, and then the body becomes prematurely old and broken down. Lately, too, the cyclist has got into the very bad habit of bending forward at his work, so that the spinal column takes an unnatural shape, which is often a prominent deformity, and which gives to other exercises and games an ungainly action. Sometimes, again, locomotion of the body in walking is made ungainly by cycling, and is impaired considerably for pedestrian feats. While, therefore, I put cycling forward as a good exercise, one in which I myself indulge, and always with pleasure, because it enables me to travel twice the distance, and with greater facility, than I could on foot, and because it affords much gratification of movement, I warn against the peril of overwork from it. When the cyclist goes so far or so quickly that the effort he has made produces an undue sense of fatigue; when his limbs are restless and twitching after he lies down in bed; when he wakes from a troubled sleep feeling that he is more tired than he was when he went to bed; then he gets the best indications he can get that he has been doing too much, and he may take my word for it that he cannot repeat this many times without doing himself injury.

Dancing has the same bad effect upon the heart and circulation when it is carried to an extreme degree. Added to that, in our modern life there is the risk attendant upon dancing in closed rooms, where the air is hot and close, and where there are so many inducements to indulgence in stimulants and late hours. Football follows the same rule; I have more than once had occasion to trace a long and severe attack of irregular circulation and strained circulation in the young from this outrageous exercise.

Horse riding by its action on the heart is in a lesser degree hurtful to the circulation when it is made too much of a task. Those who engage in what is called the sports of the field—hunting or racing—are very liable to injury of the circulation, and many of the sudden catastrophes which occur in the chase are due to sudden failures of the heart or rupture of a vessel. In riding, that action of the blood already spoken of, in which the column of blood is brought down upon the valves of the heart, and in which the great artery is distended, is much promoted by the repeated descent of the body upon the saddle. So, in old days, when we had a race of postboys, who were always in the saddle, dilatation of the aorta—aortic aneurism, so named by physicians—was of such frequent occurrence that it was actually called "postboys' disease."

Walking and climbing affect chiefly the nervous system, and men leading a studious and sedentary life are easily injured by sudden attempts to perform feats of strength of a climbing or pedestrian order. The lungs may be competent to meet a great deal of work; the muscles may be in a fair condition; but the nervous system, which gives the impetus to the muscular, which fires the shots, if I may say so, that keep the muscles going, is not in good working order. If it has been worn out by study, by confinement, and by close air, under the exertion of walking or climbing it begins to fail. The student says to himself, "When I have finished this student's task, I will take a good spell of exercise in walking or climbing; I will go to some mountainous district, and breathe at a great height the strong mountain air." He sets forth resolutely, and is astounded to find how much sooner than he expected he is fatigued. He thinks it cannot be that he is worn out, and so he keeps on until he can do no more. Then he is incapacitated, and returns to his work feeling weaker than ever, and ashamed that other men have apparently beaten him in the race. I have seen this effect in men of all ages; in the student from college, in the middle aged, in the more than middle aged. I am certain I have seen many years of life taken out of men; certain I have seen insomnia, restlessness, and general feebleness, from the strain here noticed; and I put the facts before you, as men going into the world, in the most earnest manner, that you may not fall into error, by ignorance of results.

I have no time to dwell on other games and sports, what may be considered minor games or sports, such as lawn tennis, bowls, cricket, skittles, golf, and croquet. These, which are very fine exercises, are much less liable than any that I have named to cause acute disease, and some of them are model games, in that they bring into play the muscles of the body in great groups, and afford a valuable exercise which is at all times desirable. I consider it a great pity that bowls have so much fallen into disrepute. I think it a great benefit that cricket holds its ground, and I commend lawn tennis as an admirable game.

#### EXERCISE IN UNIVERSITY LIFE.

Before I close I must deal with the question of exercise generally on university life. I think I have already said that it is always advisable to exchange physical with mental exertion, so that the body may rest on the mind, and the mind on the body in turn. I have said also that my own life has been greatly benefited by following such interchanges, and I dwell on them as a necessity of a good and healthy university career.

One day at table, not long since, I heard a number of learned men, each of whom had established himself in life favorably, discussing the question whether it were more advantageous to the future successful life of the university scholar to be first stroke or first wrangler. These men were all well acquainted with university life—most of them had gone through it; and the conclusion they arrived at from their recollections was that, numerically, the most successful men were those who had attained to the position of being first stroke. There is nothing improbable in this view, since the youth who develops the best organization is really the best fitted to fight his way in the world and gain the first place. In all the professions, strength to hold your

own is the great element of success. In the law it is obviously the fact that the strongest man physically—being, of course, well grounded mentally—is the first. The same is largely true in political life, it is strictly true in medical, it is probably true in the church, and it is unmistakably true in the public services. We have therefore to consider how, without interfering seriously with university studies, we may make the physical life the best that can be made.

Let us look at this matter for a moment longer. It is unnecessary to say more about strain and overstrain; it will be most profitable to look upon the common modes of life in feeding, drinking, clothing, sleeping, habits of the bath, cleanliness, smoking, and similar indulgences.

The practice of subsisting on excess of animal food, and taking heavy meals while training for manly exercises, is strongly to be condemned. The diet should be of a mixed kind, with, if anything, a tendency to vegetarian fare, and the meals should be equally divided into four moderate portions per day in nearly equal quantities, so that the nervous power required for digestion of the best kind of food, and for athletic work of the best kind, may be equally distributed. As to drink, water pure and simple is undoubtedly the very best. Alcoholic drinks only add to the work of the heart, and as I could show you, indisputably, if I had time to deal with and demonstrate the work of the heart, they only impose so much more labor on the work demanded by the competition or exertion itself. They are apparently, at first, stimulating, they are in the end enervating and destructive of those finest qualities of mind and body on which so much depends. This is not merely theoretical doctrine; it rests on practice, and I have learned it, as others have, by observation of phenomena. It is illustrated throughout creation; for, as you know, the strongest animals in the world, and the most rapid for movement, achieve all their physical efforts with water alone as the driver of their organic mechanism.

For covering the body during exercise the substance of clothing should be porous, so as to allow the freest transpiration from the skin, since suppressed skin action is most hurtful. When you are selecting clothing, draw a piece of the material over your mouth and feel sure that you can breathe through it without the slightest effort, breathe as if there were nothing in the way as an obstructive. You need not be afraid of cold from such material, for it soon becomes, from its porous nature, charged with air, which is one of the worst heat conductors of any substance, and is therefore the warmest and coolest of all; the best in winter, the best in summer.

For good work plenty of sleep is essential, seven to eight hours being really necessary.

"Sleep, which knits up the ravell'd sleeve of care,  
The death of each day's life, sore labour's bath,"

not only gives new life, but is the one and true remedy for fatigue. Even when fatigue produces that "fatigue fever" spoken of above, with poisoning of the body from the dangerous products derived from muscular waste from over-exertion, sleep is the true cure. Therefore, sleep long and well.

Let every care be taken to avoid mental excitement in competition. To anticipate too much, to strain too much, to maneuver too much, is always false, false in competitions of every kind, mental or physical. For both mind and body it is a golden rule to let trials come naturally, and to trust to natural, not strained powers.

Lastly, let all over-indulgent habits be put aside whenever you want good, wholesome work to be done. You ask me should smoking be put aside. I answer yes. Smoking, I admit, does not cause degeneration like alcohol, but it spoils the finer adjustment of the mental and bodily powers, and it is not in character with correct nervous and muscular functions. It may do for idle hours, it cannot do for active ones, and altogether it had better not be acquired or maintained as a luxurious habit. I need hardly say that the bath is a good aid to exercise, and that after vigorous exercise the cold douche is an excellent assistant, equalizing the circulation and tending to induce perfect sleep.

And now let me conclude by saying that good, active sports and exercises, in reason, are among the choicest means of maintaining a long and happy life, and supply the most natural justification of the poet who sang:

"The wise for health on exercise depend;  
God never made his works for man to mend."

#### MERCURY FRAMES FOR THE PHOTOGRAPHY OF COLORS.

THE method suggested by Prof. Lippmann for obtaining the reproduction of colors by photography has not yet entered the domain of practice, because it has

not been possible up to the present to procure plates in the market that fulfill the conditions that are indispensable to have the phenomenon of interference produce the desired effect. It is necessary for one to prepare them for himself, and this is somewhat like going back to the days of daguerreotypy, when there were fewer amateurs than there are to-day. Although the process is not within the reach of every one, it may nevertheless be admitted that among well informed amateur photographers there are some who are disposed at least to make experiments. It is to be hoped, too, that ere long our manufacturers of plates will succeed in furnishing us with emulsions ready for use. Several manufacturers have already elaborated very practical frames that permit of easily placing the sensitized film under the requisite conditions, that is to say, in direct contact with the mercury. We have especially remarked two styles that, under different forms, respond perfectly to the desired conditions. The one that Mr. Richard has constructed, according to the instructions of Mr. Contamine, consists (Fig. 1), like all photographic frames, of a wooden frame, H, provided with grooves that permit of putting it in

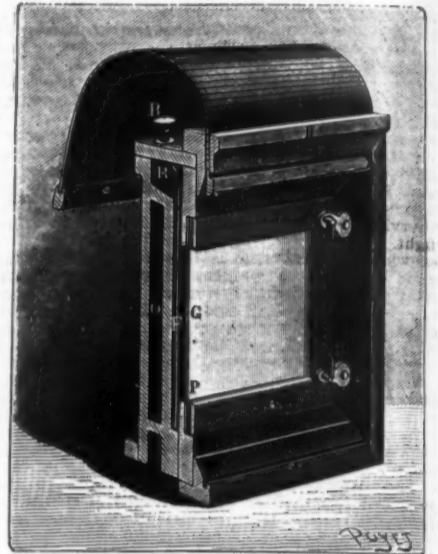


FIG. 1.—RICHARD'S MERCURY FRAME.

place back of the camera, and of a shutter or curtain designed to mask the plate until the moment of its exposure to the light. The back of the frame consists of a reservoir, A, into which mercury is poured through an aperture closed by a screw plug, B. It is divided into two parts vertically by a plate of iron, F, which is set into the frame by two sides only, the two other sides, the top and bottom, not touching the wood at all. Under such circumstances, when the frame lies flat upon its back, O, the mercury remains in the reservoir and the sensitized glass can be put in place. The latter, G, is placed upon a ledge inside of the frame, covered with chamois skin. A border of the same skin, P, is placed upon the glass and the whole is held by an iron frame, A, that is firmly fixed by four hooks, D, of which two only are visible in the figure in section. Under such circumstances, if the frame be placed vertically, the mercury will pass under the iron plate, F, and rise to take its level in the space comprised between F and G. The quantity of mercury is sufficient to cover the plate completely. After the exposure is finished, the frame is laid flat in order to change the plate or to substitute another piece of glass for it. The mercury always remains in the apparatus, and the closing effected through the chamois skin and the iron frame is sufficiently hermetic to allow it to be carried in any position and without special precautions.

In Fig. 2 we represent a model constructed by Mr. Mackenstein, and which, at least by the method of introducing the mercury, recalls the one used by the Lumiere Brothers for obtaining portraits and landscapes. The frame used is of the style called "English," that is to say, opening through the middle. The separation that exists in these frames is suppressed, and upon one of the sides is permanently fixed a plate of white glass, F. To the margin of the latter are glued strips of chamois skin and to one of the corners is fixed a tube and cock, R. The sensitized plate, G, is placed above and the frame is closed. A frame, A, with a spring, situated



FIG. 2.—MACKENSTEIN'S MERCURY FRAME.

in the counterpart that carries also the shutter, V, presses the plate, G, against the chamois skin and hermetically closes the space comprised between G and F. It is here that the mercury is introduced when the frame is in place upon the camera. To this effect, it suffices to fix at R the extremity of a rubber tube whose other end communicates with a chamois skin bag containing mercury. Upon raising this bag above the frame, the mercury fills the space comprised between the two glasses and the air escapes through the pores of the skin. The focusing can be effected as usual upon the ground glass of the camera, but that is not necessary, and it is preferable even to effect it upon the frame itself. As the back of the latter is transparent, it suffices, in fact, to place a ground glass provisionally at G, and to raise the shutter, V, so that the image may be visible when the frame is in place on the camera. Upon afterward substituting the sensitized plate for the ground glass, we are certain of an exact coincidence.

Let us hope that the creation of this new material will have the effect of causing amateurs to study a little more the interesting question of the photographic reproduction of colors.—*La Nature*.

#### THE PRESERVATION OF BUTTER.

BUTTER, after being exposed to the air for some time, becomes rancid. Rancid butter is acid and has a disagreeable odor, which is due to the saponification of glycerids and volatile acids. The rancidity of butter

soldered. It is easy to comprehend that in this process the preservative agent is carbonic acid, which is produced by degrees and impregnates the butter uniformly. This process has been the starting point for others based upon the same principle. One of the following mixtures is added to the butter: (1) bicarbonate of ammonia and tartaric acid; (2) bicarbonate of ammonia and acid phosphate of ammonia; (3) bicarbonate of soda and phosphoric acid; (4) bicarbonate of ammonia and phosphoric acid; (5) bicarbonate of soda or ammonia and acid lactate of lime or acid sulphate of potash.

The preservation of butter is assured with antiseptics such as salicylic acid, boric acid, boroglyceric acid, formic acid, formic aldehyde and asepsol. Unfortunately, all such drugs communicate to butter a taste, sui generis, that at once reveals their presence. In other processes, an endeavor is made to prevent the action of the air and micro-organisms by the use of a vacuum or of carbonic acid, under pressure, by wrapping in an impermeable and antiseptic fabric, and by an electro-metallic deposit upon the surface of the rolls of butter. One of the best processes consists in keeping the butter at a temperature of about two degrees below zero, in an atmosphere of carbonic acid, if possible. Such are the processes that are at present placed at the disposal of the butter-making industry to assure the preservation of its products.

We took up the question nearly five years ago, and, after many researches, believed that we had found the result so much demanded, through the use of carbonic

are closed, and the whole is set in a cool place; a cellar for example. The butter thus treated may be preserved for months without any alteration. At the moment of delivering it to the customer it is removed from the vessel, worked with fresh water and formed into rolls. For shipments to a distance cans like the one shown in Fig. 4 (No. 3) are used.

Butter may be preserved during the summer in the same way. It is easy then to buy it at a time when it is cheap and preserve it in vessels until it becomes dearer.—A. M. Villon, in *La Nature*.

[Continued from SUPPLEMENT, 1003, page 16050.]

#### EXPLOSIVES AND THEIR MODERN DEVELOPMENT.\*

By Professor VIVIAN B. LEWES.

##### LECTURE IV.

THE various modifications in gunpowder have been the outcome of the scientific work done upon the subject during the past five and twenty years, and have resulted in converting violent and unreliable explosive effects into beautifully modified actions which are entirely under control, and which enable the artillery officer to predict the strains which will be thrown upon the various parts of his gun, and the muzzle velocity which will be imparted to the projectile.

Smokeless powders also, having their inception at a time when the objects to be striven for were clearly in the minds of those devising them, have been brought to a point not far removed from perfection in a marvelously short period of time.

There is, however, another class of explosives which, although not attracting so much popular attention, is, from a commercial point of view, nearly as valuable and as important as the service explosives themselves, and this class constitutes the so-called "blasting explosives" used by the engineer and the miner for the removal of obstacles placed in his path by nature, and for the winning of ores and coal from their natural resting places.

In explosives for blasting purposes, the study of ballistic effects has to be abandoned for considerations of a totally different character. When the explosive is required by the engineer for such mechanical work as tunneling and the removal of rocks and other obstacles in a waterway, or when such bodies are required for the purpose of bringing down masses of slate and stone in quarries, the primary points which claim attention are, first, safety in handling; secondly, the fitness of the explosive to do the work required of it, i. e., shall it have a shattering and disintegrating effect which shall allow of the ready removal of the debris, or shall its action partake more of an upheaval and steady push, which will separate the mass in blocks fitted for cutting into slabs or other forms? thirdly, during its combustion such an explosive must not give off gases which in the confined and ill-ventilated spaces in which they have often to be used are likely to be actively dangerous to the life and health of those exposed to the air contaminated by such fumes. For use in coal mines, however, these points, although of great importance, are overshadowed by the question of safety, and the ideal in explosives for such work must also be free from the risk of giving rise to the ignition of explosive mixtures existing in the mine, whether the mixture be firedamp, traces of firedamp and dust, or mixtures of dust and air alone; but inasmuch as all explosives of this class claim perfection in both directions, it will be best to consider the composition and effect of those mining explosives most largely used in this country, and afterward to discuss how nearly they approach to these requirements.

In the earlier days of mining, gunpowder was the only blasting agent employed, but the discovery by Alfred Nobel, in 1864, that nitroglycerine could be used with tremendous effect for blasting purposes, and his patenting it under the name of "Nobel's blasting oil," gave rise to an entirely new era, and when, in 1866, the dangerous character of this substance led to legislative restrictions, it was Nobel who complied with the requirements of the time by converting his blasting oil into the powerful and effective explosive which we have already discussed under the name of dynamite.

During the succeeding years many attempts were made to modify and improve upon this idea, but the next great era in blasting explosives may be taken as being made in 1873, when Dr. Sprengel read a paper before the Chemical Society on a new class of explosives. In this paper he pointed out that in the then existing explosives there were considerable variations between the amount of available oxygen present and the amount of combustible matter to be burned by it, and that the proportions, as a rule, were not such as to give the highest explosive value, some of these bodies, as in the case of gun-cotton, containing too small an amount of oxygen for complete combustion, while nitroglycerine contains more than sufficient, and he suggested that higher explosive values could be obtained by employing mixtures which might either be solid, liquid, or the two combined, and one of which should be a hydrocarbon, containing the elements carbon and hydrogen in a condition favorable to their rapid combination with oxygen, while the second should be an easily decomposable compound, which could be made available for supplying the necessary oxygen for the combustion of the hydrocarbon, and which could be mixed with it in the proportions necessary to give the highest explosive value.

Among the advantages claimed for such explosives is the important one of safety in transit, as the mixing of the ingredients need only take place when the body is required for use, and the two constituents when separated being non-explosive, there would be no danger until such admixture was made. Dr. Sprengel showed also that mixtures of potassium chlorate and such bodies as benzene, petroleum, and phenol could be detonated and exploded with great violence. This class of explosives, named after the inventor "Sprengel explosives," has been largely adopted for blasting purposes. The principal are:

Rack-a-rock, a mixture of potassium chlorate and petroleum, or, in some cases, nitrobenzol, which obtained notoriety from being the material used in the

\* Four lectures recently delivered before the Society of Arts, London.—From the Journal of the Society.



FIG. 1.—MICROBES OF BUTTER.



FIG. 2.—CRYPTOGAMS OF BUTTER.

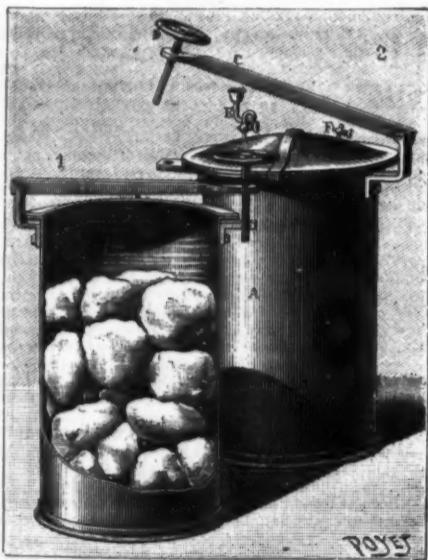


FIG. 3.—CYLINDER CONTAINING LUMPS OF BUTTER. 1. Section. 2. External view of the apparatus.



FIG. 4.—KNEADING MACHINE (4) AND CAN FOR SHIPPING BUTTER (3).

is due to several causes: (1) to the action of the air in the presence of light, which saponifies the fatty matter and splits it up into its elements, which are attacked in turn and converted into various oxidized products; and (2) to the action of microscopic organisms (microbes, cryptogams), such as the *Penicilla*, the *Oidium lactis*, the *Oleum microcladus*, etc., which saponify the butter after the manner of oxygen and light. Under the influence of ferments, butter may undergo lactic or butyric fermentation, especially when it contains much casein of milk.

Figs. 1 and 2 show the microbes and the microscopic plants that cause the various alterations of butter.

Different methods of preserving butter have been proposed. The most general one consists in adding to it from 4 to 8 per cent. of its weight of dry and finely pulverized white salt and packing it in earthen or metallic vessels in such a way as to leave no spaces, and then covering it with a disk of thin linen upon which is placed a stratum of salt. The vessel is then closed with a sheet of parchment.

In Scotland and England, a mixture of 2 parts of salt, 1 part of saltpeter, and 1 of sugar is used for salting. This mixture, which was proposed as long ago as 1705 by Anderson, is used in the proportion of 6 per cent. of the weight of the butter, to which it gives a sweeter taste.

Brown incloses the butter in tin boxes along with water slightly acidulated with 3 grammes of tartaric acid and 8 of bicarbonate of soda to the liter. The box is

acid under pressure, a method that we patented in 1890. Unfortunately, the exploitation was not practical. Moreover, the butter took on a taste in the carbonic acid that it was difficult to get rid of by washing. We had abandoned the study, which had cost much time, without reaching any serious result, when we resumed it at the beginning of 1894 in the train of our success in the preservation of milk by compressed oxygen.

Oxygen does not preserve butter. We have experimented with the entire series of harmless antiseptics without odor or taste and capable of being removed from the butter after the preservative action has been produced. We have obtained excellent results with the product called crysoleine in commerce. According to the data collected upon this product for our Dictionary of Industrial Chemistry, it is a mixture of compound ethers (camphoric and citric). It is a colorless liquid soluble to a slight degree in water.

The butter is worked with a five per cent. solution of crysoleine in the apparatus shown in Fig. 4 (No. 4). The lumps that come from this apparatus are placed in a large cylinder, A, closed by a cover, B (Fig. 3, No. 2). When this cylinder is full the cover is put on and kept in position with a lever, C, which is depressed. The hermetic closing is assured by an asbestos joint pressed by the flange of the cover and the screw, D. This done, the solution of crysoleine is poured in through the tube, E, after the air cock, F, has been opened. When the vessel is full, the cocks, E and F,

Hell Gate explosions, when the rocks at that point were destroyed.

Hellholite, a mixture of nitrated tar oils with the strongest nitric acid.

Oxonite, containing perle acid and nitric acid, which are mixed just before use.

The foregoing explosives are all prohibited for use in England, on account of their sensitiveness to friction and their general instability. On this account, in 1886, a group of safety explosives was introduced, consisting of dinitrobenzol or nitronaphthalene, mixed with either nitrate of ammonium or nitrate of potassium. The principal of these are known as ammonite, bellite, roburite, and securite, and have been specially introduced as safety explosives for mining work.

The next era in blasting explosives may be taken as dating from 1875, when Nobel, in the December of that year, took out his first patent for blasting gelatine, a substance which figured so prominently in our last lecture as the parent of our successful service explosives.

In discussing the composition and properties of these mining explosives, it will be convenient to divide them into three classes:

(1) Blasting powders of the same character as gunpowder; (2) Sprengel explosives; (3) nitroglycerine explosives; which will cover all the explosives most used for blasting purposes, with the exception of tonite, which is a mixture of nitrocotton with mineral nitrates.

Under the first heading we find ordinary gunpowder and also the commoner forms of blasting powder in which the sulphur is considerably increased at the expense of the potassium nitrate.

The following table gives an idea of the composition of such powders:

	England.	France.	Italy.
Potassic nitrate .....	65	62	70
Sulphur .....	30	30	18
Charcoal .....	15	18	12

The result of this alteration of composition is to increase the volume of permanent gases given off by the powder, and at the same time to reduce the heat energy of the explosion, but in obtaining a slight lowering of temperature, the poisonous constituent of the products of combustion, carbon monoxide, is increased to a very serious extent, and this alone should render the use of such powder inadmissible, while it has several other very serious disadvantages, which will be discussed later on.

The following table gives a clear idea of the alteration brought about in the composition of the products of combustion by the increase in the amount of sulphur present and reduction in the potassium nitrate:

	Gunpowder, fine grain.	Mining powder.
Carbon dioxide.....	56.62	32.15
Carbon monoxide .....	10.47	33.75
Nitrogen .....	38.20	19.03
Sulphuretted hydrogen.....	2.48	7.10
Marsh gas.....	0.19	2.73
Hydrogen .....	2.96	5.24
Oxygen.....	0.08	0.00
	100.00	100.00

The Sprengel explosives have been largely used for blasting purposes, both abroad and in this country; those used here consist of mixtures of nitrated hydrocarbons and ammonium or potassium nitrate. Roburite, introduced by Dr. Carl Roth, is a simple mixture of nitrate of ammonium with chlorinated metadinitrobenzol. The nitrate of ammonium is first dried and ground, then heated in a closed steam-jacketed vessel to a temperature of 80° C., and the melted organic compound is added, and the whole stirred until an intimate mixture is obtained. On cooling, the yellow powder is ready for use, and is stored in air-tight canisters, or is made up into cartridges. Owing to the deliquescent nature of the nitrate of ammonium, the finished explosive must be kept out of contact with the atmosphere, and for this reason the cartridges are waterproofed by dipping them in melted wax.

This mixture is not exploded by ordinary percussion, firing or electric sparks. If a layer of the explosive is struck a heavy blow with a hammer, the portion directly receiving the blow is decomposed, owing to the heat developed, but no detonation whatever takes place, nor are the portions of the substance around the spot struck in any way affected, while, if roburite be mixed with gunpowder, and the gunpowder be then ignited, the latter explodes and scatters the roburite without firing it.

The roburite can only be exploded by a specially powerful detonator, and on decomposition the gases evolved contain no combustible constituents, but consist only of carbon dioxide, water and nitrogen, with a small trace of hydrochloric acid gas, which is at once condensed by the large volume of water vapor evolved, and gives rise to no inconvenience.

Ammonite is another explosive of this class, which is manufactured from ammonium nitrate and dinitronaphthalene, these substances being blended in the proportions to give, as the products of combustion, carbon dioxide, water vapor and nitrogen, but during the decomposition taking place, probably some more complex action occurs, as small traces of ammonia can generally be detected.

Naphthalene,  $C_{10}H_8$ , which is obtained from coal tar, and which is, perhaps, better known as the "albo-carbon," employed in certain forms of gas lamps, is acted upon with strong nitric acid, with the replacement of two equivalents of the hydrogen by the NO<sub>2</sub> radical. The resulting compound is then carefully freed from acid, and is ready for use. Ammonium nitrate, carefully dried, is then incorporated with it by heavy edge runners in mills, which are heated by steam, and which are also fitted with arrangements by which the temperature of the charge can be con-

trolled. One hundred and fifty pounds of this mixture are ground in this way until the required degree of fineness and incorporation is arrived at, and the mixture, while warm, is passed through a sifting machine, which separates any particles not sufficiently ground, which are returned to the mill. The finished explosive is then ready for making up into cartridges, and the temperature is kept constant until the whole of the operations are finished.

The cartridge cases consist of solid-drawn tubes of a lead and tin alloy, in which the compound can be kept from the action of the atmosphere upon the deliquescent ammonium nitrate, and when the cartridge is required to be prepared for firing, a part of the metal tube at the end of the cartridge is cut off by a special tool, and the detonator with fuse attached inserted, the soft metal of the tube being pressed tight round the fuse. This substance, like roburite, only explodes when detonated by a strong charge of fulminate of mercury.

Bellite, which was patented in 1885, consists of a mixture of dinitrobenzene with ammonium nitrate, the latter being kept rather in excess.

Securite consists of ammonium nitrate and dinitrobenzene, but from the proportion of nitrate used it is probable that carbon monoxide is produced. These cartridges are coated with nitrated resin, in order to protect them from the action of the atmosphere.

The third class of mining explosives consists of nitroglycerine absorbed by various substances, which will render it less liable to accidental detonation.

Dynamite No. 1 consists of nitroglycerine absorbed by kieselguhr, and this was discussed in a former lecture.

Dynamite No. 2 consists of nitroglycerine absorbed by a mixture of potassium nitrate and charcoal, the whole being kept homogeneous by the addition of 1 per cent. of solid paraffin or ozokerit.

Lithofracteur is composed of nitroglycerine mixed with an equal weight of a mixture of sawdust, kieselguhr and baric nitrate, and generally also contains a small trace of sulphur.

Carbonite consists of 25 parts of nitroglycerine mixed with no less than 40 parts of wood meal and about 34 parts of sodic or potassic nitrate and 1 per cent. of sulphur.

All these mixtures, unless properly protected, are liable to the great drawback of occasionally exuding nitroglycerine, especially if water be present, and then they become highly dangerous to use, while another serious drawback is their liability to freeze, which will take place by continued exposure to a temperature of 4° C., or even slightly higher.

Carbodynamite, introduced by Mr. Walter Reid, consists of nitroglycerine absorbed by very lightly burned cork charcoal, the absorbent power of which is so great that not only can it be made stronger than in the other cases, but liability to exudation under water seems to be got rid of.

The other class of dynamite explosives, namely, nitroglycerine absorbed by an explosive agent, was invented by Mr. A. Nobel, who discovered that nitrated cotton would dissolve in nitroglycerine with the formation of a solid product. In practice, 93 parts of nitroglycerine are heated in a copper water bath to about 35° C. and 7 parts of nitrated cotton—a mixture of mono and dinitrocellulose—stirred in gradually. As the cotton dissolves the mixture gelatinizes, and on cooling solidifies. This substance, called "blasting gelatine," is semi-transparent, of specific gravity 1.5 to 1.6, and is not altered by submergence in water. It freezes at 40° C., but, unlike kieselguhr dynamite, it is very easily exploded in this state by shock. A bullet may be fired through a heap of unfrozen cartridges of blasting gelatine without any explosion, while similarly fired through frozen cartridges never fails in exploding them.

Gelatine dynamite and gelignite are prepared by adding potassic nitrate and wood meal to the blasting gelatine in varying portions.

The addition of 4 per cent. of camphor to the blasting gelatine increases the solidity, and at the same time makes the mixture less sensitive to shock. A preparation is made and sold under the name of camphorated gelatine. Nitromagnite, dynamagnite, forcite, Giant powder, Vulcan powder, Atlas powder, Judson powder, Hercules powder and Lignin dynamite are all modifications of the above forms of dynamite and blasting gelatine that have been used here or abroad.

We are now in a position to examine into the requirements which shall be fulfilled by a really good blasting explosive for mining work, which may be tabulated as follows:

1. Safety in handling.
  2. Safety in explosion.
  3. Safety after explosion—i. e., that the products of combustion shall be as little deleterious as possible.
- The factors which tend to safety in the handling of blasting explosives are that the substances shall not be liable to explosion except by means of a detonator, and must not be liable to ignition by ordinary knocking about or even by a chance spark, and also must not be liable to freeze.

When we come to examine the explosives in use for blasting purposes we find that the mining powders are fairly safe from these points of view as, although many authorities state that gunpowder can be exploded by a blow, the statement is somewhat misleading. It is perfectly true that if the powder be placed upon an iron anvil and then be struck so violent a blow with an iron hammer that the force of impact raises the temperature to the igniting point of the powder, you then have the portion so heated decomposing, but any one who has tried the experiment will realize that an accident from such a cause is practically impossible.

Experiments have been made which show that the power of bringing about such results depends a good deal upon the materials upon which the blow is struck, and the following list shows this, a blow from iron upon iron being most liable to give rise to ignition, while a blow from copper upon bronze is least likely; the intermediate metals show the tendency in decreasing order: Iron upon iron, iron and brass, brass and brass, lead and lead, lead and wood, copper and copper, copper and bronze.

Such ignition cannot, however, in most cases, be in any way confounded with detonation. If a thin sheet of guncotton be placed upon an iron anvil and be then

struck a heavy blow with an iron hammer, the portion of guncotton struck is ignited, but does not communicate its combustion to the surrounding mass, whereas I think it would be found that it would be impossible to detonate any portion of the sheet of guncotton without instantaneous decomposition of the whole of the mass, but we also know perfectly well that there are many substances, such as nitroglycerine and its derivatives, which would be detonated by a simple blow in this way, and it cannot be too strongly insisted upon that there is a very marked difference between the two phenomena.

If a 60 lb. weight pointed at one end be so arranged as to slide freely in a frame in such a way that its point will impinge on a rigid steel disk, it will be found that when falling from a height of from 6 to 12 inches, it will invariably detonate such substances as dynamite, gelignite, blasting gelatine, and carbonite. With guncotton or guncotton powders, the weight dropped from a height of 2 or 3 feet will give a sharp explosion of the portion immediately struck, and occasionally portions of the surrounding material may be ignited, but not exploded.

If the same experiment be tried with such Sprengel explosives as roburite, it will be found that a drop varying from one foot to 40 feet fails to detonate it, the only effect being that the small portion receiving the impact of the blow is decomposed, but no flame is seen, and there is no communication of the decomposition to the surrounding materials.

If a small quantity of dynamite be placed in such a position as to receive the impact of the blow, and be then surrounded with roburite, the whole of the mass is detonated, showing that true detonation, capable of being communicated to the surrounding material, has been set up; but when the roburite is so placed as to receive the full force of the blow, no explosion of the dynamite takes place, showing clearly that there has been no detonation.

The fact that such compounds as roburite or ammonite, containing ammonium nitrate as the oxidizing material, can be so decomposed, is at once explained by the fact that decomposition of ammonium nitrate alone can be brought about when the heat developed by the blow reaches the same temperature at which dry powdered ammonium nitrate is broken up.

Further experiments in this direction have shown that it is perfectly impossible to detonate, or completely explode, cartridges of the ammonium nitrate explosives except by a charge of nitroglycerine or its derivatives, or by mercuric fulminate. We may, therefore, take it that such explosives as ordinary blasting powder and the so-called Sprengel explosives, of which roburite may be taken as the type, are free from any chances of explosion by percussion, while nitroglycerine and the blasting explosives obtained from its admixture with other substances are liable to this, and are rendered still more unsafe by the tendency of the nitroglycerine to freeze at an easily reached temperature, the necessity of thawing them before detonation being a grave source of danger.

As regards ease of inflaming by increase of temperature or by accidental spark, it is found that the nitro compounds all have low points of ignition ranging from a few degrees below 200° C., while gunpowder ignites at a temperature which is generally given as from 295° to 316° C., and certainly could not inflame below 250° C., which is the ignition point of sulphur. I do not know that the temperature of ignition of such safety explosives as roburite has ever been ascertained, but the fact that, when a mixture of gunpowder and roburite is ignited, the roburite is scattered without ignition, certainly points to its being high.

In coming to the question of safety during explosion, we have to consider a subject of far wider and graver import, as it is upon this that the safety of the lives of thousands of miners employed in the country in winning coal from the seams largely depends.

From the time of Sir Humphry Davy's classical researches in the early part of this century on colliery explosions, the subject has always occupied an enormous amount of attention, and has enlisted a large amount of public sympathy, and yet even at the present time there are many factors which are not fully provided against.

Until quite recently explosions in mines were always attributed to the accidental ignition of mixtures of air and methane, to which the name of "firedamp" is given, and undoubtedly this cause is the prime factor in this class of disaster, and the introduction of such precautions as safety lamps at once brought about a considerable reduction in the number of explosions taking place. Many disasters, however, still continued to occur under apparently mysterious circumstances, the conditions being such that any large proportion of methane in the air of the mine appeared practically impossible, but investigations of such explosions showed that coal dust, in a dry and finely powdered condition, had generally been present in the mine at the time of the explosion, and the coked residue of this dust was found afterward on the surfaces exposed to the explosive wave, and years of experimental investigation by scientific men of the greatest ability proved the fact that air containing so small a proportion of methane as to be itself perfectly non-explosive becomes a good explosive again when holding dry and finely divided coal dust in suspension; and within the last few years explosions have taken place in mines which have always been celebrated for their freedom from any trace of methane. Further experiments have been made by Mr. H. Hall and Mr. W. Galloway, who have shown that the violent ignition of dust-laden air is possible by a blown-out shot, even if the air in the mine be free from any trace of marsh gas, and there is evidence to show that the explosion is developed in throbs or waves.

It is, therefore, found that the explosions in mines may be brought about, first by the ignition of a mixture of methane and air, in which the former rises above 1 volume to 16 of air, these mixtures being explosive until a proportion of 1 volume of marsh gas to 5 of air is reached; secondly, by mixtures of air, coal dust and methane, in which the amount of the latter may be excessively small; lastly, by mixtures of coal dust and air. With regard to those explosions caused by coal dust and air alone, the royal commission on explosions from coal dust in mines, in their second report, published this year, say:

"On a general review of the evidence on this point,

we have no hesitation in expressing our opinion that a blown-out shot may, under certain conditions, set up a most dangerous explosion in a mine, even where a firedamp is not present at all, or only in infinitesimal quantities; and while we are prepared to admit that the danger of a coal dust explosion varies greatly according to the composition of the dust, we are unable to say that any mine is absolutely safe in this respect, or that its owners can properly be absolved from taking reasonable precautions against a possible explosion from this cause. But even if we had been able to come to a different conclusion, and to agree with the minority of the witnesses examined, who think that coal dust alone cannot originate an explosion, we should still have to call attention to the serious danger which results from the action of coal dust in carrying on and extending an explosion which may have originally been set up by the ignition of firedamp."

One of the most interesting and instructive explosions which have taken place recently was that which occurred a little more than a year ago at the Camerton Collieries, Somersetshire, in which, so far as investigation could go, no trace of combustible gas could be found in the mine at any period prior to the explosion or subsequent to it, and in which everything pointed to the explosion being entirely due to the presence of dry coal dust in the air.

Of interest, also, are the experiments made by Mr. H. Hall, at the latter end of 1892 and the early part of 1893, and reported upon by him to the Secretary of State on January 23, 1893, in which he shows by conclusive experiments that dry coal dust, under conditions frequently present in coal mines, and in the entire absence of firedamp, may be inflamed by a blowout gunpowder shot, and cause a disastrous colliery explosion.

The evidence which can be collected from the investigation in the Camerton disaster, and from Mr. Hall's experiments, points, I think, to a cause for such explosions, which, as far as I know, has been overlooked, and which is, I think, worthy of the gravest attention. Both at the Camerton Colliery and in Mr. Hall's experiments, powder was the blasting agent used, and such powder as is employed for this purpose gives, among the products of its combustion, nearly half the volume of permanent gases in the condition of carbon monoxide, methane, and hydrogen, as was shown when we were discussing mining powders.

In the Camerton explosion, it seems probable that about 1½ lb. of such powder was used in the shot which caused the disaster, and this quantity of powder would give roughly a little over three feet of inflammable gas, which when mixed with pure air would give over ten cubic feet of an explosive or at any rate a rapidly burning mixture, and experiments which have been made upon the effects of firedamp and dust combined in causing colliery explosions show conclusively that even when the firedamp is present in such minute quantities as to form a mixture very far removed from the point of explosion, it still makes the mixture of coal dust and air highly explosive; and from experiments which I have made, it is perfectly clear that traces of carbon monoxide will do exactly the same thing when the air is laden with coal dust, while the temperature of ignition is slightly lower than with methane, so that in the case of the Camerton Colliery, it being perfectly well ascertained that the air was charged with coal dust, the probabilities are that not ten feet but a far larger volume of explosive mixture was formed by the rapid escape of the products of combustion into the coal-laden air, and this being ignited either by the flame or red-hot solid products driven out into it by the blown-out shot, would initiate a considerable area of explosion.

The classical researches of Professor H. Dixon have shown that hydrocarbons and probably carbon burn in air to carbon monoxide, and that this carbon monoxide will not form explosive mixtures with air or even with oxygen if they are absolutely dry, but if water vapor is present they explode owing to the oxidation of the carbon monoxide to dioxide, causing the propagation of an explosive wave, which reaches its maximum velocity when the percentage of water vapor is between five and six per cent., and inasmuch as the air of the mines would always contain some moisture, and as the products of combustion also would give a large volume of water vapor, these requirements would be amply fulfilled.

Still more conclusive on this point were Mr. Hall's experiments. In these you had a charge of blasting powder fired from a cannon suspended in the shaft the air of which was proved by careful chemical analysis to be absolutely free from any trace of combustible gas.

In order to get some idea of the condition of the air inside the pit during the explosion, samples of air were taken and were analyzed. Two brass tubes, filled with water, were fastened to the rope that was used to lower the cannon, one twenty yards from the bottom, the other forty yards from the bottom.

These tubes were so arranged and constructed that the explosion, as it passed the tubes, unsealed the outlet pipe, and the escaping water sucked in a sample of air which was trapped by a special arrangement and kept in the tube until the rope could be wound up. By this method it was intended that the sample of gas taken should represent the state of the air while the flame was passing, or directly afterward.

The tube nearest the bottom, as the analysis will show, did partly collect the gas in the above condition. The tube at the top, however, commenced to act prematurely, and was probably started by the sound wave which preceded the explosion. This tube simply contained ordinary air.

The following is an analysis of the gases found in the tube:

	Per cent.
Oxygen .....	3.9
Nitrogen .....	75.9
Carbon dioxide .....	12.1
Carbon monoxide .....	8.1
	100.0

This ingenious arrangement was due to Mr. W. J. Orman, and it is probably the first successful attempt which has been made to get a sample of gas during explosion, and there is not the slightest doubt that the presence of such an amount of carbon monoxide con-

verts mixtures of coal dust and air into a highly explosive body.

As the explosion takes place, and as the carbon monoxide already produced is oxidized to carbon dioxide by the action upon it of water vapor present, and also by its direct combustion with oxygen, the hydrogen of the water vapor is set free, while the heated coal dust also yields certain inflammable products of distillation to the air, and partial combustion also of the coal dust gives a considerable proportion of carbon monoxide once more, and this, driven rapidly ahead of the explosion, forms with more coal dust and air a new explosive zone, and so, by waves and throbs, the explosion is carried through the dust-laden galleries of the mine.

The experiments made by Mr. Hall, and investigations in various colliery explosions, make it abundantly manifest that no explosive should be licensed for use in mines, unless it can be absolutely proved that it gives off no inflammable products of combustion. The following table will show the results given by some of the explosives most largely used, which point very clearly to the fact that, with the exception of the Sprengel explosives, such as roborite and nitroglycerine itself, none of the bodies in use conform to these important requirements:

#### PRODUCTS OF COMBUSTION OF BLASTING EXPLOSIVES.

Powder.	Carbon dioxide.	Combustibles.	
		Carbon monoxide.	Hydrogen and marsh gas.
Gunpowder.....	50.6	10.5	3.1
Blasting powder.....	30.1	33.7	7.9
Sprengel explosives—			
Roburite.....	32	Nil.	Nil.
Ammonite.....	33	Nil.	Nil.
Nitroglycerine explosives—			
Nitroglycerine.....	63	Nil.	Nil.
Gelignite.....	25	7	Nil.
Carbonite.....	19	15	26
Blasting powder.....	36.5	32.5	8.6
Nitrocotton explosive—			
Tonite.....	30	8	Nil.

Not only these considerations, but Mr. Hall's experiments, point to the absolute necessity for legislative enactments at once forbidding the use of blasting powder in any coal mines, no matter how free they may appear to be from firedamp or from dust. If we examine the returns made as to deaths caused by gunpowder and other explosives in mines for the year 1893, it will be clearly seen that the exclusion of gunpowder in handling alone would do away with eighty per cent. of the accidents.

Cause of Accident.	No. of Deaths.
Spark or flame .....	8
Premature explosion, hang-fire, etc.....	8
Forcing into hole or breaking up.....	3
Unramming .....	0
Miscellaneous.....	1
	20
Deaths caused by other explosives, dynamite, gelignite, etc.....	4

So that if explosives of the Sprengel class were employed, accidents due to the explosives used would be practically eliminated from the mining death roll, and it is only a question of time as to when England will follow the action of France and Germany in altogether prohibiting the use of blasting powder in dusty mines.

If legislative action can be stirred up on this important subject, and an act be determined upon for the prohibition of dangerous explosives, it would be as well if another point intimately connected with safety in mines could be dealt with at the same time, and that is, the use of unprotected flames in many mines which have the reputation for being safe. In the South Wales district candles are in use in some large collieries, and are generally employed in the house coal seams belonging to the smaller firms.

Most steam coal companies also work a house coal seam, which lies nearer to the surface than the steam coal, and the working takes place from a separate shaft; and even some large companies, who insist on lamps and safety explosives being used in working the steam coal, allow candles and gunpowder in the house coal seams.

Large outbursts of gas rarely, if ever, take place in the house coal, but in the majority of cases, small quantities of gas escape from cracks in the roof, etc., and, as a rule, are swept away by good ventilation, unless the uneven character of the roof forms cavities in which small quantities of gas collect, and as the candles are carried by being stuck in a socket in the front of the miners' caps, they are in the position most suitable for igniting such collections of inflammable gas; and I am informed that cases are by no means infrequent in which the miner is badly burnt by a sudden puff of flame caused in this way, although no explosion in the mine may be generated.

It is manifest that, however good the record of a mine may be, the use of naked flames is running a most unnecessary risk, and one which some day or other will result in a most serious disaster. Although it might increase the financial burden on some of the smaller mine owners, the use of blasting powder and naked flame ought to be at once put down.

The safety of such Sprengel explosives as roborite in handling and in use is, to a large extent, dependent upon the fact that when the mixture of ammonium nitrate and the nitrated organic body is ignited by ordinary flame, the ammonium nitrate requires a large amount of heat for its decomposition, in order to render the oxygen which it contains available for the combustion of the carbon and hydrogen in the organic body, and the temperature of the burning substance is not sufficiently high to propagate this action

throughout the mass, the result being that to cause continued combustion you must have a continuous supply of heat, or the flame first started simply dies out.

The effect of this is that in handling, such bodies are practically non-inflammable, and when they are made to explode by detonation, a more than usually powerful detonator has to be employed, so that, although with the nitroglycerine mixtures a charge of 7 grains of mercuric fulminate is amply sufficient to produce detonation, such a body as roborite needs at least 15 grains. Moreover, when detonation has been produced, the amount of heat absorbed by the decomposition of the ammonium nitrate causes a very considerably lower temperature of explosion, as is shown in the following table, which contrasts the temperatures developed by the more prominent explosives:

	Degrees C.
Blasting gelatine.....	3,220
Nitroglycerine.....	3,170
Dynamite.....	2,940
Gun cotton.....	2,650
Tonite.....	2,648
Pierie acid.....	2,630
Roburite.....	2,100

The temperature at which mixtures of marsh gas and air ignite is between 650° and 700° C., and although the temperatures of explosion are so enormously high, they only occasionally ignite an inflammable mixture of the gases, this being due to the fact that in order to ignite firedamp, not only must the temperature of ignition be reached, but it must be sustained for several seconds before the gases inflame, and as the explosion by detonation is instantaneous, ignition does not occur; if, however, some of the charge burns instead of detonating, the gaseous mixture is fired.

With mixtures of carbon monoxide and air, however, if coal dust be present, ignition takes place directly the required temperature is reached.

The last requirement of a perfect blasting powder is that it should emit no fumes which are noxious to health, and this brings us face to face with the question of the definition of the term "noxious." The complete products of combustion, which are inseparable from all explosives, are carbon dioxide and water vapor, and I have heard people when in an excessively hypercritical condition of mind allege that carbon dioxide should be classed among the fumes which are injurious to health, but I am inclined to deny this, although we all know perfectly well that the carbon dioxide present in the atmosphere in quantities much above 4 parts in 10,000 affects health, yet we are perfectly well aware also that it has no toxic effect upon the system, its action being to retard the interchange of oxygen and carbon dioxide in the blood by the process of diffusion in the lungs. The best proof that it has no practical poisonous effect on the system being that it is evolved by nearly all the functions of the body.

If we enter into an atmosphere of carbon dioxide, death ensues within a few minutes, but is brought about in precisely the same way as if we had held our head under water for an equal length of time, and I have never yet heard of pure water being classed as a noxious substance.

The true noxious vapors are those which have a definite toxic action upon the system, and of these practically the only one evolved during explosion under pressure, or by detonation, is carbon monoxide; and a reference to the table giving the products of combustion of the various substances will make it clear that those bodies which may be used with safety, as regards the risk of giving rise to an explosion in a dusty mine, are also free from danger in this respect.

It is not long since that a high authority on explosive matters regretted that there was not such a thing as an electric lamp which could be looked upon as perfectly safe for use in explosive factories, or in fiery mines, and in concluding my subject to-night I should like to draw your attention to one which has been devised in order to meet these requirements, and which, having been exhaustively tested with regard to its safety, has been largely used at one of the South Metropolitan Gas Works, for such dangerous operations as cleaning the interior of gas holders, tanks, purifiers, etc. It consists of an incandescent lamp mounted upon the end of a short glass tube. In the middle of the tube is sealed a platinum disk in such a way as to be gas tight. To the disk is attached a metal spring leading to one terminal, and the other terminal is connected to a wire which passes outside the glass tube, and is sealed into the outer inclosing glass envelope, which surrounds the whole of the lamp and half the glass tube, communication having been previously established between the interior of the tube and the outer envelope by means of a hole in the tube. In the outer half of the tube a platinum wire is inserted and adjusted in such a way that when air is forced into the outer envelope, the platinum disk is depressed and makes contact with this wire. The lamp thus made consists of two gastight divisions separated by the disk, the larger one containing the lamp, one terminal and half length of glass tube, the other and smaller one containing the platinum wire. Air, or an inert gas, under pressure is sealed up in the outer envelope, causing the disk to be depressed, thus making contact with the wire, and enabling the current to pass. If the outer envelope be broken, the air escapes, the platinum disk resumes its flat condition, and contact is broken, any sparking that may arise on the rupture of the current being confined to the smaller gastight division, thus obviating any risk of igniting inflammable gaseous mixtures. Instead of introducing air under pressure in the outer envelope, a vacuum may be formed, when the connections between the disk and wire will have to be altered accordingly.

In concluding this course of lectures, I extremely regret that the short time at my disposal has prevented me from touching upon many subjects which I should have liked to have gone into, such as fuses, detonators, and the relative safety of the different methods employed for firing a charge, and I can only hope that my audience have found some points of interest in my meager attempt to interest them in the modern development of explosives.

## ACETYLENE FOR GAS PURPOSES.

At the recent meeting of the New England Association of Gas Engineers, Dr. Wilkinson said: From earliest history of gas manufacture acetylene has been considered a very desirable article to have in coal gas. The coal gas that was first made from rich cannel coal contained from one-half to about 3 per cent. of acetylene. You will find, on reading almost any of the old books on gas manufacture, that acetylene was looked upon as a very desirable article; but the attempt to produce it on a commercial scale has only recently been made. In the making of aluminum, where we use coke, lime and clay, it was discovered that a substance was made which, when thrown into water, gave off a gas, and which, upon applying light, took fire. This substance was examined and found to be the carbide of calcium. In the days of Sir Humphry Davy, carbide of calcium was known; so that it is not entirely a new article. All that is new about it is the possibility of producing it on a commercial scale. It requires the high heat of the electric current to cause the combination of calcium, which is the basis of lime and carbon. Now that we are making aluminum on a large scale, this as a by-product possibly may be of great interest. Where there is wasted water power you may possibly be able to make this very cheaply—as, for instance, at Niagara Falls, where they use the water power for making electricity at night for the various towns in that locality. In the daytime, having no use for electricity, they could use that power for making this carbide of calcium, and possibly could make it very cheaply.

You will find various statements made as to its value in producing gas, and some of them are to the effect that you can make from 10,000 to 15,000 ft. of gas from a ton. Its value would, of course, depend upon the purity of the article. If you are making it as a by-product in the manufacture of aluminum, the article will not be very pure, because there is a certain quantity of silicic acid that must be got rid of; but with pure caustic lime and pure coke dust, you would then have the cost of the lime, the cost of the coke and the handling of the material to make up the expense of production. It is claimed that possibly this might sell for \$3 or \$5 per ton. Now, you all know the price of a ton of lime, the price of a ton of coke dust and the cost of handling these things. It can be made cheaply on a very large scale; and as a by-product it might possibly be manufactured a little cheaper. So there is the possibility that we have now within our reach a substance to enrich coal gas aside from petroleum oil. That in itself is a very interesting fact. We do not require such a large percentage of this substance to make a very high candle power. From the experiments which I have made I will say that 2 or 3 per cent. added to coal gas will increase its candle power from 16 to 20 candles, and, at the same time, we are getting a clear, white light. With water gas I was greatly disappointed in the experiments made with this gas, for even 30 per cent. of acetylene failed to enrich the gas to 20 candles. You are aware that natural gas is almost completely light carbureted hydrogen; 5 or 6 per cent. of acetylene will enrich that to 20 candles, and it will burn clear and bright. In this country, where naphtha is so cheap, it would be hard to compete with it; but in England, where naphtha is more expensive, this substance may be of great use. In small places, where they make coal gas alone, and would like to have a higher candle power, a little of this substance will increase the candle power with very little trouble.

You see from the experiment made to-day that you have only to introduce it into water and the gas is at once given out. The resulting compound left behind is merely slaked lime. So that, by throwing a given quantity of this carbide of calcium into water, a given quantity of gas is driven off. This may be added before the purifiers, or afterward, for it is perfectly pure. When manufactured in a commercial way it is possible there may be a little sulphureted hydrogen or phosphureted hydrogen present, but the quantity would be so small as not to interfere. When made, the gas can be compressed to a liquid, and then, as the pressure is released, it will instantly spring back to gas, without loss of candle power. I see it is reported that it will give possibly 300 candles. I have not been able to get as high as that; but it is very much higher than gas made from oil—probably double. For the lighting of cars in place of Pintsch gas it will be a very desirable thing. To enrich poor coal gas it is very desirable, as also to enrich natural gas. It remains for those who have the process in hand to produce this substance so cheap that we gas men can use it. Of course, at the present prices, it is out of the question; but at from \$5 to \$10 per ton, or equal to the price of cannel coal, it would be very desirable. I do not know that there is anything more I can say about it. A company in New York have taken this subject up and propose to furnish carbide of calcium on a commercial scale. When they do, we will have an opportunity to learn more about it. Chemically, it is one of the greatest curiosities of the day.

If you are using pure coke dust and pure caustic lime, you will have a very pure article which will yield from 10,000 to 15,000 feet per ton; but if you are making it as a by-product, you introduce foreign substances, such as silica (for you know aluminum is made from silicate of aluminum), and there you will have an impurity which will reduce the quantity of gas made to probably one-half; so that it will depend entirely upon the purity of the material that you use. If they were making it commercially and without any regard to the making of aluminum, they could produce a very pure article. Carbide of calcium has a great affinity for water. Like caustic lime, it will air-slake—it will give up its gas from the moisture derived from the air—consequently it will have to be sent to you in sealed cans or barrels, so that moisture may be kept entirely from it. When you throw it into water it will liberate gas, and you can store it in that way, or you can compress it with pumps. Of course, you can store it in the holder first, then compress it with pumps into cylinders for use on cars; or, if you want it simply to enrich coal gas, you can store it in the holder. If you want to enrich 1,000 ft. of coal gas 5 per cent., 1 lb. of this will give you 5 ft. or 2 ft., according to its purity. You add that, and allow it to pass in with your coal gas. Being a perfect gas, it will, by diffusion, unite with

your coal gas, and so, in a very short time, you will see the increased candle power. Two or three per cent. added to ordinary 16 candle coal gas will bring your candle power up from 16 to 23 or 25 candles.

As far as the gas itself is concerned, they have proposed to use it for the air gas machines instead of using naphtha. Now in the ordinarily constructed air gas machine you want about 50 per cent. of the vapor of gasoline and 50 per cent. of air. It is found that about 40 per cent. of this substance will make a very high candle power, and that the gas will burn well in an open burner. Of course, like all hydrocarbon gases, you can make an explosive compound of it; and before you have reached the stage of highest illumination you can form an explosive compound. More than that, of course, it would burn with a smoky flame. As regards its action on copper, I may say that in the old gas works a good deal of copper tubing was used, and it was noticed that there was deposited inside of the copper tubing a compound which, when struck by a hammer, would explode. After that people were very careful in handling the old copper tubing from gas works, for it would explode almost equal to gunpowder when struck or when heated; this forms with copper a compound which is explosive, as it does also with brass. It also forms an explosive compound with silver. These are all well known explosive compounds. But in our ordinary works I do not think we need anticipate any trouble from that source, as the small amount of copper that we have in our stopcocks would not be sufficient to cause any difficulty. The use of copper piping about our works is a thing of the past. So in that respect I do not think we have anything to fear.

It is not always possible to have pure gas. The compound that you will get with hydrogen and sulphur will make an impure gas. There are always present impurities, and one of the impurities is most likely to be a sulphide. The sulphide of calcium when added to water will produce sulphureted hydrogen. It is also possible that you may have phosphorus present, and that will give you the phosphide of calcium, that when thrown on water will give you phosphureted hydrogen, which will take fire when exposed to the air. It is what is known as the "will-of-the-wisp." Phosphureted hydrogen is given off wherever organic matter is undergoing decomposition. It is not likely to be present, but you will understand that if your lime is not pure (if you use oyster shell lime), a great deal of organic matter is present.

The parties who have this thing in hand contemplate its manufacture on a commercial basis more cheaply than present prices. They say, for instance, there is a great water power at Niagara Falls; they may use that at night, and then for six or eight hours every day the power is idle; wherefore, if we can make the carbide of calcium during the day we can possibly make it very cheaply. As regards its competing with naphtha, you will see that if it is \$5 or \$10 per ton you can compare that with cannel coal at \$10 per ton, from which you get about the same quantity of gas. Of course, cannel coal will not enrich in proportion anything like what this substance would. As an enricher for water gas it has been a disappointment to all of us. With 10 per cent. of acetylene in water gas the gas burns blue; 20 per cent. gives you a little better light, while 40 per cent. gives you a beautiful light.

## LIQUEFACTION OF OXYGEN.

At a recent meeting of the Royal Academy of Sciences, Amsterdam, Prof. Kamerlingh Onnes read a paper on the Kryogenic Laboratory at Leyden, and on the production of extremely low temperatures. The object of the author in starting his investigations, upward of ten years ago, viz., the combination of Wroblewski's and Olszewski's labors with those of Pictet, has been quite satisfactorily attained with the least possible means. Liquid oxygen is stored in a glass vessel adapted for experimenting and observing purposes; the oxygen vapors are continuously compressed, liquefied, and again poured into the said vessel, so that the evaporation from the surface takes place at a level pretty nearly constant. With the aid of a small quantity of circulating oxygen, a bath of liquefied gas of quarter to a half liter can be maintained under normal or reduced pressure, ad libitum. With this method no use is made of Dewar's vacuum vessels. The vessel is protected from convective transference of heat by the oxygen vapor, which cools a special chamber with plate glass windows. These windows remain quite free from hoar frost, and do not interfere with the formation of images. The condensation of oxygen is obtained in a spiral tube immersed in liquid ethylene boiling in a copper flask connected with a conjugate vacuum pump and compressor. The circulating ethylene is liquefied in a condenser cooled down to -80° by a circulation of methyl chloride, or in some cases by carbonic acid. The apparatus is so arranged, and the flask especially is so devised, that only a minimum of condensed gases is required. Only one and a half kilogrammes of ethylene is used in the author's ethylene circulation to obtain the above mentioned permanent liquid oxygen bath, in contradistinction to the great quantities mentioned in the accounts of Dewar's experiments. The purifying of gases by means of fractionating at low temperatures was also treated, and a modified form of Cailletet's mercury plunger compressor, used specially for this purpose, was described. The author concluded with a few observations on certain investigations and apparatus in course of execution, and intended to be preparatory to the manipulation of liquid hydrogen in the Kryogenic Laboratory of the future.

## THE PREPARATION OF LITMUS SOLUTION.

LITMUS solution of good quality can be prepared as follows: The dye stuff in cubes, as commonly sold, is placed in a percolator and extracted with distilled water. The extract is evaporated until it equals the weight of the original litmus, then treated with three times its weight of ninety per cent. alcohol, made strongly acid with hydrochloric acid and allowed to stand for two days. Azolitmin is precipitated in brown clots, while the accompanying dirty violet coloring matter remains dissolved in the alcohol. The precipitate is collected on a filter and washed two or three times with acidulated hot water, until the filtrate,

which is faintly red in color, becomes on treatment with ammonia pure blue, without any violet tinge. The purified azolitmin thus obtained is brought into solution in water made faintly alkaline with ammonia, and the solution is diluted with distilled water until it is equal to three and half times the weight of the original litmus. It is then accurately neutralized and preserved by the addition of ten per cent. of alcohol. The litmus solution thus prepared leaves nothing to be desired, its change of color, when used as an indicator, being perfectly sharp.—W. Schafer, Apoth. Zeit., 1894, ix, p. 539; through Chem. Zeit.

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